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THE DEADLIEST, COSTLIEST, AND MOST INTENSE UNITED STATES TROPICAL CYCLONES FROM 1851 TO 2004 (AND OTHER FREQUENTLY REQUESTED HURRICANE FACTS)

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PREFACE

This version of the Deadliest, Costliest, and Most Intense United States Tropical Cyclones extends the work of Jarrell et al. (2001) to begin with the year 1851. New updates include data from the period 1851-1899 provided by the best track reanalysis project headed by Chris Landsea, some significant revisions to the period 1900-1914 and a revised intensity of Hurricane Andrew [Landsea et al. (2004)]. A new feature for this update is a list of landfalling hurricanes during this era, updating and supplementing information provided in Neumann et al. (1999). The paper continues the methodology of Jarrell et al. (2001) in producing an estimate of the monetary loss that historical hurricanes could exact on the current property-at-risk in the same location.

During 1995, the National Meteorological Center, which included the National Hurricane Center, was re-organized into the National Centers for Environmental Prediction (NCEP). Under NCEP, the National Hurricane Center became the Tropical Prediction Center (TPC), a name which more accurately reflects the broad scope of its responsibilities, and more formally publicizes that the majority of its operational products were for tropical weather events exclusive of hurricanes. The name "National Hurricane Center" was retained to apply to the hurricane operations desk at TPC. We will follow the convention where "NHC" refers to the previous National Hurricane Center, "TPC" refers to the current center and "TPC/NHC" refers to the hurricane operations desk of TPC.

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ABSTRACT

This technical memorandum lists the deadliest and costliest tropical cyclones in the United States during 1851-2004. The compilation ranks damage, as expressed by monetary losses, in three ways: 1) contemporary estimates; 2) contemporary estimates adjusted by inflation to 2004 dollars; and 3) contemporary estimates adjusted for inflation and the growth of population and personal wealth [Pielke and Landsea, 1998] to 2004. In addition, the most intense (i.e., major[1]) hurricanes to make landfall in the United States during the period are listed. Some additional statistics on United States hurricanes of this and previous centuries, and tropical cyclones in general, are also presented.

1. INTRODUCTION

The staff of the Tropical Prediction Center receives numerous requests for statistical information on deaths and damages incurred during tropical cyclones affecting the United States. Information about their intensity is also frequently of interest. Estimates of these measures vary in the literature. Our hope is to present the best compilation of currently available estimates. In some instances, data in our lists represent revised estimates based on more complete information received following earlier publications including previous versions of this technical memorandum.

There are other frequently asked questions about hurricanes, such as: What is the average number of hurricanes per year? What year(s) had the most and least hurricanes? What hurricane had the longest life? On what date did the earliest and latest hurricane occur? What was the most intense Atlantic hurricane? What was the largest number of hurricanes in existence on the same day? When was the last time a major hurricane or any hurricane hit a given community directly[2]? Answers to these and several other questions are provided in Section 3.

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[1] A major hurricane is a category 3, 4, or 5 hurricane on the Saffir/Simpson Hurricane Scale (see Table 1), and is comparable to a Great Hurricane in some other publications.

[2] A direct hit means experiencing the core of strong winds and storm surge of a hurricane.

Table 1. Saffir/Simpson Hurricane Scale [Simpson, R.H. (1974)].

Scale Number (Category)	Central Pressure (Millibars)	(Inches)	Winds (Mph)	Surge (Feet)	Damage
1	> 979	> 28.91	74-95	4 to 5	Minimal
2	965-979	28.50-28.91	96-110	6 to 8	Moderate
3	945-964	27.91-28.47	111-130	9 to 12	Extensive
4	920-944	27.17-27.88	131-155	13 to 18	Extreme
5	< 920	< 27.17	> 155	> 18	Catastrophic

2. BACKGROUND AND DEFINITIONS

Many of the statistics in this publication depend directly on the criteria used in preparing another study, "Hurricane Experience Levels of Coastal County Populations-Texas to Maine" [(Jarrell et al. (1992)]. The primary purpose of that study was to demonstrate, county by county, the low hurricane experience level of a large majority of the population. Statistics show that the largest loss of life and property occur in locations experiencing the core of a category 3 or stronger hurricane.

The Saffir/Simpson category is defined by pressure, wind, and storm surge. In nature, however, there is not a one-to-one relationship between these elements. Therefore, in practice, the TPC uses the maximum wind speed to establish the category. Operationally, however, the central pressure is often used to make a first estimate of the wind. Thereafter, available surface wind reports, aircraft reconnaissance flight-level winds (from which surface wind speed can be estimated), and dropsonde data are used to anchor the wind estimate. In post-storm analysis, the central pressure ranges of hurricanes on the Saffir/Simpson Hurricane Scale will usually agree fairly well with the wind ranges in that category. On the other hand, the storm surge is strongly dependent on the slope of the continental shelf (shoaling factor). This can change the height of the surge by a factor of two for a given central pressure and/or maximum wind.

Heavy rainfall associated with a hurricane is not one of the criteria for categorizing.

The process of assigning a category number to a hurricane is subjective, as is TPC's estimate of a cyclone's impact . It is made on a county by county basis. In this study, we continue to use criteria for direct hit and indirect hit described in the work by Jarrell et al. (1992):

> Direct Hit - Using "R" as the radius of maximum winds in a hurricane (the distance in miles from the storm's center to the circle of maximum winds around the center), all or parts of counties falling within approximately 2R to the right and R to the left of a storm's landfall point were considered to have received a direct hit. (This assumes an observer at sea looking toward the shore. If there was no landfall, the closest point of approach was used in place of the landfall point). On average, this direct hit zone extended about 50 miles along the coastline (R≈15 miles). Of course, some hurricanes were smaller than this and some, particularly at higher latitudes, were much larger. Cases were judged individually, and many borderline situations had to be resolved.

Indirect Hit - In general, areas on either side of the direct hit zone which received wind gusts of hurricane force and/or tides of at least 4 to 5 feet above normal were considered to have had an indirect hit. The evaluation subjectively incorporated a hurricane's strength and size, and the configuration of county coastlines.

The authors acknowledge that there are limitations to this technique. For example, the effect of an indirect hit by a large category 4 hurricane can be greater than that by a direct hit from a small category 1 hurricane.

Neumann et al. (1999) gives the variation in tropical cyclone frequency along the United States coastline for all tropical storms and hurricanes, hurricanes only, and major hurricanes (category 3 or greater). In that study, counts were made of the number of tropical cyclones or hurricanes whose center passed within 75 nautical miles of the coastal location. This counting method thus includes near-misses, as well as direct and indirect hits as defined above.

Statistics on tropical storm and hurricane activity in the North Atlantic Ocean (which includes the Gulf of Mexico and the Caribbean Sea) can be found in Neumann et al. (1999). A stratification of hurricanes by category which have affected coastal counties of the Gulf of Mexico and North Atlantic Ocean can be found in Jarrell et al. (1992). Additional information about the impact of hurricanes can be found in annual hurricane season articles in Monthly Weather Review , Storm Data and Mariner's Weather Log.

3. DISCUSSION

Part I

The remainder of this memorandum provides answers to some of the most frequently asked questions about the characteristics and impacts of the tropical cyclones to affect the United States from 1851-2004.

(1) **What have been the deadliest tropical cyclones in the United States?** Table 2 lists the tropical cyclones that have caused at least 25 deaths on the U.S. mainland 1851-2004. The Galveston Hurricane of 1900 was responsible for at least 8000 deaths and remains #1 on the list. The death total from the Lake Okeechobee Hurricane of 1928 has been revised to include work from Pfost (2003) to reflect that the hurricane killed at least 2500 people. Tropical Storm Allison in 2001 caused torrential flooding in the Houston area and is the most significant addition since 2000 to the list. However two powerful hurricanes that struck in 1893 are now #3 and #4 on the list. A tropical storm which affected southern California in 1939 and the deadliest Puerto Rico and Virgin Islands hurricanes are listed as addenda.

(2) **What have been the costliest tropical cyclones in the United States?** Table 3a lists the 30 costliest tropical cyclones to strike the U.S. mainland 1900-2004. No monetary estimates are available before 1900 and figures are not adjusted for inflation. The 2004 hurricane season had the second, third, fourth and sixth most-costly systems to strike the United States. Table 3b re-orders the first list and adds several other hurricanes after adjusting to 2004 dollars[3]. Hawaiian, Puerto Rican and Virgin Island tropical cyclones are listed as addenda to Tables 3a and 3b. Table 3b also lists the thirty costliest hurricanes 1900-2004 assuming that a hurricane having the same track, size and intensity as noted in the historical record would strike the area with today's population totals and property-at-risk. See Pielke and Landsea (1998).

(3) **What have been the most intense hurricanes to strike the United States?** Table 4 lists the 60 most intense major hurricanes to strike the U.S. mainland 1851-2004. Hurricanes are ranked by estimating central pressure at time of landfall. Hawaiian, Puerto Rican and Virgin Island hurricanes are listed as addenda to Table 4.

A look at the lists of deadliest and costliest hurricanes reveals several striking facts: (1) Fourteen out of the fifteen deadliest hurricanes were the equivalent of a category 3 or higher. (2) Large death totals were primarily a result of the 10 feet or greater rise of the ocean (storm surge) associated with many of these major hurricanes. About three-quarters of the deadliest hurricanes were major hurricanes. (3) A large portion of the damage in four of the fifteen costliest tropical cyclones (Table 3a) resulted from inland flooding caused by torrential rain. (4) One-third of the deadliest hurricanes were category four or higher, but only one-seventh of the costliest hurricanes met this criterion. (5) Only five of the deadliest hurricanes occurred during the past twenty five years in contrast to three-quarters of the costliest hurricanes (this drops to one-half after adjustment for inflation and about one-third after adjustment for inflation, population, and personal wealth).

Addenda to tables 2 through 4 include some noteworthy storms from the U.S. West coast and the Hawaiian Islands, as well as in the U. S. Caribbean Islands. The rank represents the position they would occupy if included in the main table.

[3] Adjusted to 2004 dollars on basis of U.S. Department of Commerce Implicit Price Deflator for Construction. Available index numbers are rounded to the nearest tenth. This rounding can result in slight changes in the adjusted damage of one hurricane relative to another.

Table 2. Mainland U.S. tropical cyclones causing 25 or greater deaths 1851-2004.

RANK	HURRICANE	YEAR	CATEGORY	DEATHS
1	TX (Galveston)	1900	4	8000 [a]
2	FL (SE/Lake Okeechobee)	1928	4	2500 [b]
3	LA (Cheniere Caminanda)	1893	4	1100-1400 [c]
4	SC/GA (Sea Islands)	1893	3	1000-2000 [e]
5	GA/SC	1881	2	700
6	FL (Keys)	1935	5	408
7	LA (Last Island)	1856	4	400
8	*AUDREY* (SW LA/N TX)	1957	4	390
9	FL (Miami)/MS/AL/Pensacola	1926	4	372
9	LA (Grand Isle)	1909	3	350
11	FL (Keys)/S TX	1919	4	287 [d]
12	LA (New Orleans)	1915	4	275
12	TX (Galveston)	1915	4	275
14	New England	1938	3	256 [d]
14	*CAMILLE* (MS/SE LA/VA)	1969	5	256
16	*DIANE* (NE U.S.)	1955	1	184
17	GA, SC, NC	1898	4	179
18	TX	1875	3	176
19	SE FL	1906	3	164
20	TX (Indianola)	1886	4	150
21	MS/AL/Pensacola	1906	2	134
22	FL, GA, SC	1896	3	130
23	*AGNES* (FL/NE U.S.)	1972	1	122 [i]
24	*HAZEL* (SC/NC)	1954	4	95
25	*BETSY* (SE FL/SE LA)	1965	3	75
26	Northeast U.S.	1944	3	64 [o]
27	*CAROL* (NE U.S.)	1954	3	60
28	*FLOYD* (Mid Atlantic & NE U.S.)	1999	2	56
29	NC	1883	2	53
30	SE FL/SE LA/MS	1947	4	51
31	NC, SC	1899	3	50 [g,h]
31	GA/SC/NC	1940	2	50
31	*DONNA* (FL/Eastern U.S.)	1960	4	50
34	LA	1860	2	47 [g]
35	NC, VA	1879	3	46 [g,l]
35	*CARLA* (N & Central TX)	1961	4	46
37	TX (Velasco)	1909	3	41
37	*ALLISON* (SE TX)	2001	TS [f]	41
39	Mid-Atlantic	1889	none [n]	40 [g,l]
39	TX (Freeport)	1932	4	40
39	S TX	1933	3	40
42	*HILDA* (LA)	1964	3	38
43	SW LA	1918	3	34
44	SW FL	1910	3	30
44	*ALBERTO* (NW FL, GA, AL)	1994	TS [f]	30
46	SC, FL	1893	3	28 [k]
47	New England	1878	2	27 [g,f]
47	Texas	1886	2	27 [g]
49	*FRAN* (NC)	1996	3	26
50	LA	1926	3	25
50	*CONNIE* (NC)	1955	3	25
50	*IVAN* (NW FL, AL)	2004	3	25
ADDENDUM (Not Atlantic/Gulf Coast)				
2	Puerto Rico	1899	3	3369 [h]
5	P.R., USVI	1867	3	811 [i,j]
5	Puerto Rico	1852	1	800 [i,j]
13	Puerto Rico (San Felipe)	1928	5	312
17	USVI, Puerto Rico	1932	2	225
25	*DONNA* (St. Thomas, VI)	1960	4	107
25	Puerto Rico	1888	1	100 [g]
37	Southern California	1939	TS [f]	45
37	*ELOISE* (Puerto Rico)	1975	TS [f]	44
47	USVI	1871	3	27 [g]

Notes:

a	Could be as high as 12,000
b	Could be as high as 3000
c	Total including offshore losses near 2000
d	Total including offshore losses is 600
e	August
f	Only of Tropical Storm intensity.
g	At least
h	Puerto Rico 1899 and NC, SC are the same storm
i	No more than
j	Possibly a total from two hurricanes
k	Mid-October
l	Could include some offshore losses
m	Four death at shoreline or just offshore
n	Remained offshore
o	Total including offshore losses is 390

Table 3a. The thirty costliest mainland United States tropical cyclones, 1900-2004.

RANK	HURRICANE	YEAR	CATEGORY	DAMAGE (U.S.)
1	*ANDREW* (SE FL/SE LA)	1992	5	$26,500,000,000
2	*CHARLEY* (SW FL)	2004	4	15,000,000,000
3	*IVAN* (AL/NW FL)	2004	3	14,200,000,000
4	*FRANCES* (FL)	2004	2	8,900,000,000
5	*HUGO* (SC)	1989	4	7,000,000,000
6	*JEANNE* (FL)	2004	3	6,900,000,000
7	*ALLISON* (N TX)	2001	TS @	5,000,000,000
8	*FLOYD* (Mid-Atlantic & NE U.S.)	1999	2	4,500,000,000
9	*ISABEL* (Mid-Atlantic)	2003	2	3,370,000,000
10	*FRAN* (NC)	1996	3	3,200,000,000
11	*OPAL* (NW FL/AL)	1995	3	3,000,000,000
12	*FREDERIC* (AL/MS)	1979	3	2,300,000,000
12	*AGNES* (FL/NE U.S.)	1972	1	2,100,000,000
14	*ALICIA* (N TX)	1983	3	2,000,000,000
15	*BOB* (NC, NE U.S)	1991	2	1,500,000,000
15	*JUAN* (LA)	1985	1	1,500,000,000
17	*CAMILLE* (MS/SE LA/VA)	1969	5	1,420,700,000
18	*BETSY* (SE FL/SE LA)	1965	3	1,420,500,000
19	*ELENA* (MS/AL/NW FL)	1985	3	1,250,000,000
20	*GEORGES* (FL Keys, MS, AL)	1998	2	1,155,000,000
21	*GLORIA* (Eastern U.S.)	1985	3	900,000,000
22	*LILI* (SC LA)	2002	1	860,000,000
23	*DIANE* (NE U.S.)	1955	1	831,700,000
24	*BONNIE* (NC,VA)	1998	2	720,000,000
25	*ERIN* (NW FL)	1998	2	700,000,000
26	*ALLISON* (N TX)	1989	TS @	500,000,000
26	*ALBERTO* (NW FL,GA,AL)	1994	TS @	500,000,000
26	*FRANCES* (TX)	1998	TS @	500,000,000
29	*ELOISE* (NW FL)	1975	3	490,000,000
30	*CAROL* (NE U.S.)	1954	3	461,000,000
ADDENDUM (Rank is independent of other events in group)				
15	*GEORGES* (USVI,PR)	1998	3	1,800,000,000
15	*INIKI* (Kauai, HI)	1992	Unk.	1,800,000,000
17	*MARILYN* (USVI, PR)	1995	2	1,500,000,000
21	*HUGO* (USVI, PR)	1989	4	1,000,000,000
26	*HORTENSE* (PR)	1996	1	500,000,000

Notes:

@ Only of Tropical Storm intensity

Table 3b. The thirty costliest mainland United States tropical cyclones, 1900-2004.

Ranked Using 2004 Deflator**

RANK	HURRICANE	YEAR	Category	Damage (Millions)**
1	*ANDREW* (SE FL/SE LA)	1992	5	$43,672
2	*CHARLEY* (SW FL)	2004	4	15,000
3	*IVAN* (NW FL/AL.)	2004	3	14,200
4	*HUGO* (SC)	1989	4	12,250
5	*AGNES* (FL/NE U.S.)	1972	1	11,290
6	*BETSY* (SE FL/SE LA)	1965	3	10,799
7	*FRANCES* (SE FL)	2004	2	8,900
8	*CAMILLE* (MS/SE LA/VA)	1969	5	8,889
9	*DIANE* (NE U.S.)	1955	1	6,997
10	*JEANNE* (SE FL)	2004	3	6,900
11	*FREDERIC* (AL/MS)	1979	3	6,291
12	New England	1938	3	5,971
13	*ALLISON* (N TX)	2001	TS	5,829
14	*FLOYD* (Mid Atlantic & NE U.S.)	1999	2	5,764
15	NE U.S.	1944	3	5,386
16	*FRAN* (NC)	1996	3	4,525
17	*ALICIA* (N TX)	1983	3	4,384
18	*OPAL* (NW FL/AL)	1995	3	4,324
19	*CAROL* (NE U.S.)	1954	3	3,949
20	*ISABEL* (NC/VA)	2003	4	3,643
21	*JUAN* (LA)	1985	1	3,105
22	*DONNA* (FL/Eastern U.S.)	1960	4	3,040
23	*CELIA* (S TX)	1970	3	2,761
24	*BOB* (NC, NE U.S)	1991	2	2,593
25	*ELENA* (MS/AL/NW FL)	1985	3	2,588
26	*CARLA* (N & Central TX)	1961	4	2,366
27	FL (Miami,Pensacola)/MS/AL	1926	4	2,058
28	*ELOISE* (NW FL)	1975	3	2,008
29	N TX (Galveston)	1915	4	1,990 [1]
30	*DORA* (NE FL)	1964	2	1,964
ADDENDUM				
25	*INIKI* (Kauai, HI)	1992	Unk.	2,563
27	*GEORGES* (USVI,PR)	1998	3	2,276
30+	*MARILYN* (USVI,E. PR)	1995	2	1,900
30+	*HUGO* (USVI, PR)	1989	4	1,502
30+	San Felipe (PR)	1928	5	1,424

Ranked Using 2004 Inflation, Population and Wealth Normalization[L]

RANK	HURRICANE	YEAR	Category	Damage (Millions)[L]
1	SE Florida/Alabama	1926	4	$101,973
2	ANDREW (SE FL/LA)	1992	5	43,152
3	N Texas (Galveston)	1900	4	37,541
4	N Texas (Galveston)	1915	4	31,808 [1]
5	SW Florida	1944	3	23,784
6	New England	1938	3 *	23,451
7	SE Florida/Lake Okeechobee	1928	4	19,456
8	BETSY (SE FL/LA)	1965	3	17,536
9	DONNA (FL/Eastern U.S.)	1960	4	16,993
10	CAMILLE (MS/LA/VA)	1969	5	15,464
11	AGNES (NW FL, NE U.S.)	1972	1	15,096
12	CHARLEY (SW FL)	2004	4	15,000
13	DIANE (NE U.S.)	1955	1	14,430
14	IVAN (NW FL, AL)	2004	3	14,200
15	HUGO (SC)	1989	4	13,228
16	CAROL (NE U.S.)	1954	3	12,785
17	SE Florida/Louisiana/Alabama	1947	4	11,716
18	CARLA (N & Central TX)	1961	4	9,970
19	HAZEL (SC/NC)	1954	4	9,927
20	NE U.S.	1944	3	9,113
21	SE Florida	1945	3	8,904
22	FRANCES (SE FL)	2004	2	8,900
23	FREDERIC (AL/MS)	1979	3	8,876
24	SE Florida	1949	3	8,233
25	S Texas	1919	4	7,543
26	JEANNE (SE FL)	2004	3	6,900
27	ALLISON (TX/LA)	2001	TS	6,254
28	ALICIA (N TX)	1983	3	5,721
29	FLOYD (NC)	1999	2	5,475
30	CELIA (S TX)	1970	3	4,708

notes

** 2004 $ based on U.S. DOC Implicit Price Deflator for Construction.

L Based on Pielke and Landsea (1998) normalization for population, wealth and inflation

1 Damage estimate in 1915 reference is considered too high

Table 4. The most intense mainland United States hurricanes, 1851-2004 (includes only major hurricanes at their most intense landfall).

RANK	HURRICANE	YEAR	CATEGORY (at landfall)	MINIMUM PRESSURE Millibars	Inches
1	FL (Keys)	1935	5	892	26.35
2	*CAMILLE* (MS/SE LA/VA)	1969	5	909	26.84
3	*ANDREW* (SE FL/SE LA)	1992	5	922	27.23
4	*TX* (Indianola)	1886	4	925	27.31
5	FL (Keys)/S TX	1919	4	927	27.37
6	FL (Lake Okeechobee)	1928	4	929	27.43
7	*DONNA* (FL/Eastern U.S.)	1960	4	930	27.46
8	LA (New Orleans)	1915	4	931	27.49
8	*CARLA* (N & Central TX)	1961	4	931	27.49
10	LA (Last Island)	1856	4	934	27.58
10	*HUGO* (SC)	1989	4	934	27.58
12	FL (Miami)/MS/AL/Pensacola	1926	4	935	27.61
13	TX (Galveston)	1900	4	936	27.64
14	GA/FL (Brunswick)	1898	4	938	27.70
14	*HAZEL* (SC/NC)	1954	4	938	27.70
16	SE FL/SE LA/MS	1947	4	940	27.76
17	N TX	1932	4	941	27.79
17	*CHARLEY* (SW FL)	2004	4	941	27.79
19	*GLORIA* (Eastern U.S.)	1985	3 &	942	27.82
19	*OPAL* (NW FL/AL)	1995	3 &	942	27.82
21	FL (Central)	1888	3	945	27.91
21	E NC	1899	3	945	27.91
21	*AUDREY* (SW LA/N TX)	1957	4 #	945	27.91
21	TX (Galveston)	1915	4 #	945	27.91
21	*CELIA* (S TX)	1970	3	945	27.91
21	*ALLEN* (S TX)	1980	3	945	27.91
27	New England	1938	3	946	27.94
27	*FREDERIC* (AL/MS)	1979	3	946	27.94
27	*IVAN* (AL, NW FL)	2004	3	946	27.94
30	NE U.S.	1944	3	947	27.97
30	SC/NC	1906	3	947	27.97
32	LA (Chenier Caminanda)	1893	3	948	27.99
32	*BETSY* (SE FL/SE LA)	1965	3	948	27.99
32	SE FL/NW FL	1929	3	948	27.99

	ADDENDUM				
4	*DAVID* (S of PR)	1979	4	924	27.29
8	San Felipe (PR)	1928	5	931	27.49
16	*HUGO* (USVI & PR)	1989	4	940	27.76
41	*INIKI* (KAUAI, HI)	1992	UNK	950	27.91
60	*DOT* (KAUAI, HI)	1959	UNK	955	28.11

RANK	HURRICANE	YEAR	CATEGORY (at landfall)	MINIMUM PRESSURE Millibars	Inches
32	SE FL	1933	3	948	27.99
32	S TX	1916	3	948	27.99
32	MS/AL	1916	3	948	27.99
38	NW FL	1882	3	949	28.02
38	*DIANA* (NC)	1984	3 +	949	28.02
38	S TX	1933	3	949	28.02
41	GA/SC	1854	3	950	28.05
41	LA/MS	1855	3	950	28.05
41	LA/MS/AL	1860	3	950	28.05
41	LA	1879	3	950	28.05
41	*BEULAH* (S TX)	1967	3	950	28.05
41	*HILDA* (Central LA)	1964	3	950	28.05
41	*GRACIE* (SC)	1959	3	950	28.05
41	TX (Central)	1942	3	950	28.05
41	*JEANNE* (FL)	2004	3	950	28.05
50	SE FL	1945	3	951	28.08
50	*BRET* (S TX)	1999	3	951	28.08
52	LA (Grand Isle)	1909	3	952	28.11
52	FL (Tampa Bay)	1921	3	952	28.11
52	*CARMEN* (Central LA)	1974	3	952	28.11
54	SC/NC	1885	3	953	28.14
54	S FL	1906	3	953	28.14
56	GA/SC	1893	3	954	28.17
56	*EDNA* (New England)	1954	3	954	28.17
56	SE FL	1949	3	954	28.17
56	*FRAN* (NC)	1996	3	954	28.17
60	SE FL	1871	3	955	28.20
60	LA/TX	1886	3	955	28.20
60	SC/NC	1893	3	955	28.20
60	NW FL	1894	3	955	28.20
60	*ELOISE* (NW FL)	1975	3	955	28.20
60	*KING* (SE FL)	1950	3	955	28.20
60	Central LA	1926	3	955	28.20
60	SW LA	1918	3	955	28.20

Notes

& Highest category justified by winds.
# Classified 4 because of estimated winds.
+ Cape Fear, NC area only; was a category 2 at final landfall.

Table 5 summarizes the direct hits on the U. S. mainland since 1851. The data indicate that an average of 3 major hurricanes every 5 years made landfall somewhere along the U.S. Gulf or Atlantic coast. (All categories combined average about 5 hurricanes every 3 years.) Note that not all areas of the U.S. were settled before 1900 and there could be substantial gaps in landfall data coverage, especially in South Florida. For more details see Landsea et al. (2004b).

Table 5. Direct hits by mainland United States Hurricanes (1851-2004).

Category	Direct Hits
5	3
4	18
3	71
2	72
1	109
TOTAL	273
MAJOR	92

Major hurricanes are categories 3,4 & 5.

One of the greatest concerns of the National Weather Service's (NWS) hurricane preparedness officials is that the statistics in Table 2 will mislead people into thinking that no more large loss of life will occur in a hurricane because of our advanced technology. Max Mayfield, spokesman for the NWS hurricane warning service and Director of TPC, as well as former NHC Directors, have repeatedly emphasized the great danger of a catastrophic loss of life in a future hurricane if proper preparedness plans for vulnerable areas are not formulated, maintained and executed.

The study by Jarrell et al. (1992) used 1990 census data to show that 85% of U.S. coastal residents from Texas to Maine had never experienced a direct hit by a major hurricane. This risk is higher today as an estimated 50 million residents have moved to coastal sections during the past twenty-five years. The experience gained through the landfall of Charley, Ivan, Jeanne, Andrew and Hugo has not lessened an ever-growing concern brought by the continued increase in coastal populations.

Table 6, which lists hurricanes by decades since 1851, shows that during the forty year period 1961-2000 both the number and intensity of landfalling U.S. hurricanes decreased sharply! Based on 1901-1960 statistics, the expected number of hurricanes and major hurricanes during the period 1961-2000 was 75 and 28, respectively. But, in fact, only 55 (or 74%) of the expected number of hurricanes struck the U.S. with only 20 major hurricanes or 71% of that expected number. Even the very active late 1990s showed below average landfall frequencies. It could be noted that of the most recent four decades, only the 70's and 80's were significantly below normal in terms of overall tropical cyclone activity.

During the past 35 years, the United States has experienced three Category 4 or stronger hurricanes: Charley in 2004, Andrew of 1992 and Hugo of 1989. However, on the average, a category 4 or stronger hurricane strikes the United States once every 6 or 7 years. This suggests we have seen fewer exceptionally strong hurricanes than an expected 35 year average of about 5 or 6. Fewer hurricanes do not necessarily mean a lesser threat of disaster, however. Records for the most intense U.S. hurricane in 1935, and the costliest, Andrew in 1992, occurred in years which had much below-average hurricane activity.

A large death toll in a U.S. hurricane is still possible. The decreased death totals in recent years could be as much a result of lack of major hurricanes striking the most vulnerable areas as they are of any fail-proof forecasting, warning, and observing systems.

Continued coastal growth and inflation will almost certainly result in every future major landfalling hurricane (and even weaker hurricanes and tropical storms) replacing one of the current costliest hurricanes. For example, 4 out of 6 hurricane landfalls of 2004 made the top 30 list.

Table 6. Number of hurricanes by category to directly strike the mainland U.S. each decade. (Updated from Jarrell et al., 2001)

	Category					ALL	Major
DECADE	1	2	3	4	5	1,2,3,4,5	3,4,5
1851-1860	8	5	5	1	0	19	6
1861-1870	8	6	1	0	0	15	1
1871-1880	7	6	7	0	0	20	7
1881-1890	8	9	4	1	0	22	5
1891-1900	8	5	5	3	0	21	8
1901-1910	10	4	4	0	0	18	4
1911-1920	10	4	4	3	0	21	7
1921-1930	5	3	3	2	0	13	5
1931-1940	4	7	6	1	1	19	8
1941-1950	8	6	9	1	0	24	10
1951-1960	8	1	5	3	0	17	8
1961-1970	3	5	4	1	1	14	6
1971-1980	6	2	4	0	0	12	4
1981-1990	9	1	4	1	0	15	5
1991-2000	3	6	4	0	1	14	5
2001-2004	4	2	2	1	0	9	3
1851-2004	109	72	71	18	3	273	92
Average per decade	7.1	4.7	4.6	1.2	0.2	17.7	6.0

Note: Only the highest category to affect the U.S. has been used

If warnings are heeded and preparedness plans developed, the death toll can be reduced. In the absence of a change of attitude, policy, or laws governing building practices (codes and location) near the ocean, however, large property losses are inevitable.

Part II

This section answers some frequently asked questions about tropical storm and hurricane activity.

(1) What is the average number of hurricanes per year? Table 7 gives the average number of tropical cyclones which reached tropical storm, hurricane and major hurricane strength during selected time periods. A total of eleven tropical systems reaching storm strength with six of these becoming hurricanes and two attaining major hurricane status are the best averages to use based on the past 40 year time period of routine satellite surveillance.

Table 7. Average number of tropical cyclones* which reached storm, hurricane and major hurricane strength for various periods. Updated from Neumann et al. (1999).

PERIOD	Number of Years	Average number of Tropical Storms	Average number of Hurricanes	Average number of Major Hurricanes
1851 - 2004	154	8.5	5.2	1.8
1944 - 2004	61	10.3	6.0	2.6
1955 - 2004	50	10.3	5.9	2.4
1965 - 2004	40	10.6	5.9	2.2
1975 - 2004	30	10.8	6.0	2.3
1985 - 2004	20	11.5	6.4	2.6
1990 - 2004	15	12.2	6.7	2.9
1995 - 2004	10	13.9	7.8	3.8

*Includes subtropical storms after 1967

(2) What year(s) have had the most and least hurricanes? Table 8a shows the years of maximum and minimum tropical storm and hurricane activity for the Atlantic hurricane basin. Table 8b lists the years of maximum United States hurricane landfalls. The only times that the U.S. mainland has gone as long as two years without a hurricanes are 1862-64, 1930-31, 1981-82 and 2000-01. Note there is considerable uncertainty before 1900 because significant areas of the Gulf and Southeast Atlantic coasts were unpopulated and uninstrumented. The largest

Table 8a. Years of maximum and minimum tropical storm and hurricane activity in the Atlantic basin 1851-2004. Updated from Neumann et al. (1999).

MAXIMUM ACTIVITY			
TROPICAL STORMS[1]		HURRICANES	
Number	Years	Number	Years
21	1933	12	1969
19	1887,1995	11	1887,1916,1950, 1995
18	1969		
16	1936,2003	10	1870,1878,1886,
15	2000,2001,2004		1893,1933,1998
14	1916,1953,1990 1998	9	1880,1955,1980, 1996,2001,2004
MINIMUM ACTIVITY*			
TROPICAL STORMS[1]		HURRICANES	
Number	Years	Number	Years
1	1914	0	1907,1914
2	1925,1930	1	1905,1919,1925
3	1917,1919,1929	2	1851,1854,1890,
4	1854,1857,1868, 1883,1884,1890, 1911,1913,1920, 1983		1895,1917,1922, 1930,1931,1982

Notes

[1] Includes subtropical storms after 1967.

*likely underpresented before reconnaissance in 1944

number of hurricanes to strike in one year was seven (1886), with six occurring in 1916, 1985, and 2004, plus five in 1893, 1909 and 1933. Three or four hurricanes have struck the U.S. in one year a total of 37 times. Eleven U.S. hurricanes were recorded in the two-year period 1886-87 with 15 recorded from 1886-1888.

Table 8a. Years of maximum United States hurricane strikes 1851-2004.

MAXIMUM U. S. HURRICANE STRIKES

Number	Years
7	1886
6	1916,1985,2004
5	1893,1909,1933
4	1852,1869,1880,1887, 1888,1906,1964
3	30 years have exactly 3 strikes

(3) When did the earliest and latest hurricanes occur? The hurricane season is defined as June 1 through November 30. An early hurricane can be defined as occurring in the three months prior to the start of the season, and a late hurricane can be defined as occurring in the three months after the season. With these criteria the earliest observed hurricane in the Atlantic was on March 7, 1908, while the latest observed hurricane was on December 31, 1954, the second "Alice" of that year which persisted as a hurricane until January 5, 1955. The earliest hurricane to strike the United States was Alma which struck northwest Florida on June 9, 1966. The latest hurricane to strike the U. S. was late on November 30, 1925 near Tampa, Florida.

(4) What were the longest-lived and shortest-lived hurricanes? The third system of 1899 holds the record for most days as a tropical storm (28) and major hurricane (11.5), while Ginger in 1971 holds the record for the most days as a hurricane (20). There have been many tropical cyclones which remained at hurricane intensity for 12 hours or less.

(5) What were the strongest and weakest hurricanes? In terms of central pressure (and probably winds), the strongest observed hurricane in the Atlantic basin was Gilbert in 1988 with a pressure of 888 millibars in the northwestern Caribbean with estimated sustained winds of 185 mph. The 1935 Labor Day hurricane in the Florida Keys, with a pressure of 892 millibars, was the most intense hurricane to strike the United States. Numerous hurricanes have reached only the minimum wind speed near 74 miles per hour and struck the United States.

(6) How many hurricanes have there been in each month? Table 9, adapted from Neumann et al. (1999), shows the total and average number of tropical storms, and those which became hurricanes, by month, for the period 1851-2004. It also shows the monthly total and average number of hurricanes to strike the U. S. since 1851 (updated from Jarrell et.al. (2001).

Table 9. Tropical storms and hurricanes in the Atlantic, Caribbean and Gulf of Mexico by month of origin, 1851-2004 [updated from Neumann et al. (1999)], and for hurricanes striking the U.S. mainland 1851-2004 [updated from Jarrell et al., (2001)].

	TROPICAL STORMS[1]		HURRICANES		U.S. HURRICANES	
MONTH	Total	Average	Total	Average	Total	Average
JANUARY-APRIL	5	*	1	*	0	0.00
MAY	18	0.1	4	*	0	0.00
JUNE	76	0.5	28	0.2	19	0.12
JULY	94	0.6	47	0.3	23	0.15
AUGUST	336	2.2	214	1.4	74	0.48
SEPTEMBER	448	2.9	309	2.0	102	0.67
OCTOBER	273	1.8	154	1.0	50	0.33
NOVEMBER	58	0.4	38	0.2	5	0.03
DECEMBER	8	0.1	4	*	0	0.00
YEAR	1316	8.5	799	5.2	273	1.78

[1] Includes subtropical storms after 1967. See Neumann et al. (1999) for details.
* Less than 0.05.

(7) What was the largest number of hurricanes in the Atlantic Ocean at the same time? Four hurricanes occurred simultaneously on two occasions. The first occasion was August 22, 1893, and one of these eventually killed 1,000-2,000 people in Georgia-South Carolina. The second occurrence was September 25, 1998, when Georges, Ivan, Jeanne and Karl persisted into September 27, 1998 as hurricanes. Georges ended up taking the lives of thousands in Haiti. In 1971 from September 10 to 12, there were five tropical cyclones at the same time; however, while most of these ultimately achieved hurricane intensity, there were never more than two hurricanes at any one time.

(8) How many direct hits by hurricanes of various categories have affected each state? Table 10, updated from Jarrell et al. (2001), shows the number of hurricanes affecting the United States and individual states, i.e., direct hits. The table shows that, on the average, close to seven hurricanes every four years (~1.75 per year) strike the United States, while about three major hurricanes cross the U.S. coast every five years (0.60 per year). Other noteworthy facts, updated from Jarrell et al. (2001), are: 1.) Forty percent of all U.S. hurricanes hit Florida; 2.) Eighty-three percent of category 4 or higher hurricanes strikes have hit either Florida or Texas; 3.) Pennsylvania's only hurricane strike between 1851-2004 was 1878.

Table 10. Hurricane direct hits on the mainland U.S. coastline and for individual states 1851-2004 by Saffir/Simpson category. Updated from Jarrell et al. (2001).

AREA	CATEGORY NUMBER 1	2	3	4	5	ALL	MAJOR HURRICANES
U.S. (Texas to Maine)	109	72	71	18	3	273	92
Texas	23	17	12	7	0	59	19
(North)	12	6	3	4	0	25	7
(Central)	7	5	2	2	0	16	4
(South)	9	5	7	1	0	22	8
Louisiana	17	14	13	4	1	49	18
Mississippi	2	5	7	0	1	15	8
Alabama	11	5	6	0	0	22	6
Florida	43	32	27	6	2	110	35
(Northwest)	27	16	12	0	0	55	12
(Northeast)	13	8	1	0	0	22	1
(Southwest)	16	8	7	4	1	36	12
(Southeast)	13	13	11	3	1	41	15
Georgia	12	5	2	1	0	20	3
South Carolina	19	6	4	2	0	31	6
North Carolina	21	13	11	1	0	46	12
Virginia	9	2	1	0	0	12	1
Maryland	1	1	0	0	0	2	0
Delaware	2	0	0	0	0	2	0
New Jersey	2	0	0	0	0	2	0
Pennsylvania	1	0	0	0	0	1	0
New York	6	1	5	0	0	12	5
Connecticut	4	3	3	0	0	10	3
Rhode Island	3	2	4	0	0	9	4
Massachusetts	5	2	3	0	0	10	3
New Hampshire	1	1	0	0	0	2	0
Maine	5	1	0	0	0	6	0

Notes:

State totals will not equal U.S. totals, and Texas or Florida totals will not necessarily equal sum of sectional totals. Regional definitions are found in Appenix A

(9) **When are the major hurricanes likely to strike given areas?** Table 11 shows the incidence of major hurricanes by months for the U.S. mainland and individual states. September has as many major hurricane landfalls as October and August combined. Texas and Louisiana are the prime targets for pre-August major hurricanes. The threat of major hurricanes increases from west to east during August with major hurricanes favoring the U.S. East Coast by late September. Most major October hurricanes occur in southern Florida.

Table 11. Incidence of major hurricane direct hits on the U.S. mainland and individual states, 1851-2004, by month. Updated from Jarrell et al. (2001).

AREA	JUNE	JULY	AUG.	SEPT.	OCT.	ALL
U.S. (Texas to Maine)	2	4	26	43	17	92
Texas	1	1	10	7		19
c (North)	1	1	3	2		7
b (Central)			2	2		4
a (South)			5	3		8
Louisiana	2		6	7	3	18
Mississippi		1	3	4		8
Alabama		1	1	4		6
Florida		1	6	19	9	35
a (Northwest)		1	1	7	3	12
d (Northeast)				1		1
b (Southwest)			2	5	5	12
c (Southeast)			4	8	3	15
Georgia			1	1	1	3
South Carolina			2	2	2	6
North Carolina			4	7	1	12
Virginia				1		1
Maryland						0
Delaware						0
New Jersey						0
Pennsylvania						0
New York			1	4		5
Connecticut			1	2		3
Rhode Island			1	3		4
Massachusetts				3		3
New Hampshire						0
Maine						0

Note: State totals do not equal U.S. totals and Texas or Florida totals do not necessarily equal the sum of sectional entries. Florida and Texas regional definitions are found in Appendix A.

(10) How long has it been since a hurricane or a major hurricane hit a given community? A chronological list of all hurricanes to strike the United States 1900 through 1990 including month, states affected by category of hurricane, and minimum sea level pressure at landfall can be found in Jarrell et al. (1992). Appendix A extends that publication to cover the entire database from 1851-2004. Table 12 summarizes the occurrence of the last hurricane and major hurricane to directly hit the most populated coastal communities from Brownsville, Texas to Eastport, Maine. In addition, if a hurricane indirectly affected a community after the last direct hit, it is listed in the last column of the table. In order to obtain the same type of information listed in Table 12 for the remaining coastal communities, the reader is again referred to Jarrell et al. (1992) or NOAA Coastal Services (http://hurricane.csc.noaa.gov/hurricanes/index.htm). There are many illustrative examples of the uncertainty of when a hurricane might strike a given locality. After nearly 70 years without a direct hit, Pensacola, Florida was hit directly by Hurricane Erin in 1995 and major Hurricane Ivan in 2004 within 10 years. Miami, which expects a major hurricane every nine years, on average, has been struck only once since 1950 (in 1992). Tampa has not experienced a major hurricane for 84 years. Many locations along the Gulf and Atlantic coasts have not experienced a major hurricane during the period 1851-2004 (see Table 12).

(11) What is the total United States damage (before and after adjustment for inflation) and death toll for each year since 1900? Table 13a summarizes this information. Table 13b ranks the top 30 years by deaths, by unadjusted damage and by adjusted damage. In most years the death and damage totals are the result of a single, major hurricane. Gentry (1966) gives damages adjusted to 1957-59 costs as a base for the period 1915-1965. For the most part, death and damage totals for the period 1915-1965 were taken from Gentry's paper, and for the remaining years from *Monthly Weather Review*. Adjusted damages were converted to 2004 dollars by the factors used in Table 3a.

(12) What are the deadliest and costliest hurricanes to affect Hawaii, Puerto Rico and the U.S. Virgin Islands since 1900? Table 14, provided by Hans Rosendal and Raphael Mojica of the Weather Service Forecast Offices in Honolulu and San Juan, respectively, summarizes this information. Iniki in 1992 is the deadliest and costliest hurricane to affect Hawaii while Georges of 1998 is the costliest hurricane to affect Puerto Rico. The notorious San Felipe hurricane of 1928 was the deadliest hurricane in Puerto Rico since 1900.

Table 12. Last direct or indirect hit by any hurricane or a major hurricane at certain populated coastal communities. Category in parenthesis. Updated from Jarrell et al. (1992).

State	City	Direct Hits: Last Major		Direct Hits: Last Any	Indirect Hits: Last any
Texas	Brownsville	1980(3)	Allen	1980(3) Allen	
	Corpus Christi	1970(3)	Celia	1971(1) Fern	1980(3) Allen
	Port Aransas	1970(3)	Celia	1971(1) Fern	1980(3) Allen
	Matagorda	1961(4)	Carla	2003(1) Claudette	
	Freeport	1983(3)	Alicia	1983(3) Alicia	2003(1) Claudette
	Galveston	1983(3)	Alicia	1989(1) Jerry	
	Houston	1941(3)		1989(1) Jerry	
	Beaumont	<1860		1986(1) Bonnie	
Louisiana	Cameron	1957(4)	Audrey	1985(1) Danny	1985(1) Juan
	Morgan City	1992(3)	Andrew	1992(3) Andrew	2002(1) Lili
	Houma	1974(3)	Carmen	1985(1) Juan	1992(3) Andrew
	New Orleans	1965(3)	Betsy	1965(3) Betsy	1969(5) Camille
Mississippi	Bay St. Louis	1985(3)	Elena	1985(3) Elena	
	Biloxi	1985(3)	Elena	1998(2) Georges	
	Pascagoula	1985(3)	Elena	1998(2) Georges	
Alabama	Mobile	1985(3)	Elena	1998(2) Georges	2004(3) Ivan
Florida	Pensacola	2004(3)	Ivan	2004(3) Ivan	
	Panama City	1995(3)	Opal	1995(3) Opal	
	Apalachicola	1985(3)	Elena	1998(2) Earl	1995(3) Opal
	Homosassa	1950(3)	Easy	1968(2) Gladys	
	St. Petersburg	1921(3)		1946(1)	1968(2) Gladys
	Tampa	1921(3)		1946(1)	1968(2) Gladys
	Sarasota	1944(3)		1946(1)	1966(2) Alma
	Fort Myers	1960(3)	Donna	1960(3) Donna	2004(4) Charley
	Naples	1960(4)	Donna	1964(2) Isbell	1992(3) Andrew
	Key West	1948(3)		1999(1) Irene	
	Miami	1992(5)	Andrew	1999(1) Irene	
	Fort Lauderdale	1950(3)	King	1999(1) Irene	1992(5) Andrew
	W. Palm Beach	1949(3)		1999(1) Irene	2004(3) Jeanne
	Stuart	2004(3)	Jeanne	2004(3) Jeanne	
	Fort Pierce	2004(3)	Jeanne	2004(3) Jeanne	
	Vero Beach	2004(3)	Jeanne	2004(3) Jeanne	

State	City	Direct Hits: Last Major		Direct Hits: Last Any		Indirect Hits: Last any
Florida	Cocoa	<1900		1995(1)	Erin	2004(3) Jeanne
	Daytona Bch	<1880		1960(2)	Donna	1979(2) David
	St. Augustine	<1880		1964(2)	Dora	
	Jacksonville	<1880		1964(2)	Dora	
	Fernandina Bch	<1880		1928(2)		1964(2) Dora
Georgia	Brunswick	1898(4)		1928(1)		
	Savannah	1854(3)		1979(2)	David	
S. Carolina	Hilton Head	1959(3)	Gracie	1979(2)	David	1985(1) Bob
	Charleston	1989(4)	Hugo	1989(4)	Hugo	
	Myrtle Beach	1954(4)	Hazel	1954(4)	Hazel	1989(4) Hugo
N. Carolina	Wilmington	1996(3)	Fran	1999(2)	Floyd	1999(2) Dennis
	Morehead City	1996(3)	Fran	1999(2)	Floyd	2003(2) Isabel
	Cape Hatteras	1993(3)	Emily	2003(2)	Isabel	2004(1) Alex
Virginia	Virginia Beach	1944(3)		2003(1)	Isabel	
	Norfolk	<1851		2003(1)	Isabel	1999(1) Floyd
Maryland	Ocean City	<1851		<1851		1985(3) Gloria
	Baltimore	<1851		1878(1)		1954(2) Hazel
Delaware	Rehoboth Bch	<1851		<1851		1985(3) Gloria
	Wilmington	<1851		<1851		1954(2) Hazel
New Jersey	Cape May	<1851		1903(1)		1985(3) Gloria
	Atlantic City	<1851		1903(1)		1985(3) Gloria
New York	New York City	<1851		1903(1)		1976(1) Belle
	Westhampton	1985(3)	Gloria	1985(3)	Gloria	
Connecticut	New London	1938(3)		1991(2)	Bob	
	New Haven	1938(3)		1985(2)	Gloria	
	Bridgeport	1954(3)	Carol	1985(2)	Gloria	
Rhode Island	Providence	1954(3)	Carol	1991(2)	Bob	
Mass.	Cape Cod	1954(3)	Edna	1991(2)	Bob	
	Boston	1869(3)		1960(1)	Donna	1991(1) Bob
N. Hampshire	Portsmouth	<1851		1985(2)	Gloria	
Maine	Portland	<1851		1985(1)	Gloria	
	Eastport	<1851		1969(1)	Gerda	1985(1) Gloria

Notes: <1900 means before 1900 etc.

Table 13a. Estimated annual deaths and damages (unadjusted and adjusted for inflation[1] and normalized[L] for inflation, growth in personal wealth and population) in the mainland United States from landfalling Atlantic or Gulf tropical cyclones 1900-2004.

		DAMAGE ($Millions)					DAMAGE ($Millions)		
Year	Deaths	Unadjusted	Adjusted[1]	Normalized[L]	Year	Deaths	Unadjusted	Adjusted[1]	Normalized[L]
1900	8,000 +	30	1235 [2]	37,541	1952	3	3	20	82
1901	10	1	41 [2]	904	1953	2	6	41	37
1902	0	Minor	Minor	0	1954	193	756	5,140	22,844
1903	15	1	41 [2]	9,730	1955	218	985	6,562	17,204
1904	5	2	82 [2]	1,177	1956	19	27	170	456
1905	0	Minor	Minor	0	1957	400	152	933	3,186
1906	298	3 +	123 [2]	5,739	1958	2	11	67	290
1907	0	Minor	Minor	0	1959	24	23	143	582
1908	0	Minor	Minor	0	1960	65	396	2,464	15,918
1909	406	8	329 [2]	4,121	1961	46	414	2,588	9,340
1910	30	1	41 [2]	1,591	1962	3	2	12	55
1911	17	1 +	41 [2]	304	1963	10	12	73	194
1912	1	Minor	Minor	0	1964	49	515	3,174	9,193
1913	5	3	123 [2]	920	1965	75	1,445	8,664	16,557
1914	0	Minor	Minor	0	1966	54	15	86	215
1915	550	63	2592 [3]	33,344	1967	18	200	1,113	2,673
1916	107	33	1115	5,077	1968	9	10	53	417
1917	5	Minor	Minor	0	1969	256	1,421	6,994	14,298
1918	34	5	110	516	1970	11	454	2,109	4,352
1919	287	22	434	7,543	1971	8	213	927	1,580
1920	2	3	47	514	1972	122	2,100	8,603	13,978
1921	6	3	59	4,584	1973	5	18	68	123
1922	0	Minor	Minor	0	1974	1	150	498	933
1923	0	Minor	Minor	0	1975	21	490	1,489	2,290
1924	2	Minor	Minor	0	1976	9	100	290	400
1925	6	Minor	Minor	0	1977	0	10	27	42
1926	408	112	2186	104,908	1978	36	20	48	100
1927	0	Minor	Minor	0	1979	22	3,045	6,574	11,264
1928	2,500	25	488	19,457	1980	2	300	584	1,128
1929	3	1	18	190	1981	0	25	45	102
1930	0	Minor	Minor	0	1982	0	Minor	Minor	36
1931	0	Minor	Minor	0	1983	22	2,000	3,422	5,289
1932	40	8	166	2,558	1984	4	66	109	170
1933	63	47	1085	4,892	1985	30	4,000	6,450	8,567
1934	17	5	105	517	1986	9	17	26	38
1935	414	12	252	4,469	1987	0	8	12	17
1936	9	2	44	146	1988	6	59	86	115
1937	0	Minor	Minor	0	1989	56	7,670	10,672	13,436
1938	600	306	5971	23,464	1990	13	57	77	96
1939	3	Minor	Minor	0	1991	16	1,500	2,005	2,234
1940	51	5	102	722	1992	24	26,500	34,955	43,152
1941	10	8	151	1,410	1993	4	57	72	83
1942	8	27	444	1,647	1994	38	973	1,187	1,339
1943	16	17	262	2,131	1995	29	3,723	4,369	4,860
1944	64	165	2539	33,133	1996	36	3,600	4,129	4,544
1945	7	80	1202	9,958	1997	4	100	111	121
1946	0	5	64	3,162	1998	23	4,344	5,817	5,484
1947	53	136	1454	15,196	1999	62	5,532	5,737	6,222
1948	3	18	175	2,383	2000	6	27	27	32
1949	4	59	573	8,707	2001	45	5,260	6,132	6,254
1950	19	36	344	3,958	2002	9	1,220	1,383	1,411
1951	0	2	17	256	2003	24	3,600	3,892	3,970
					2004	60	45,000	45,000	45,000

+ 1900 could have been as high as 12,000, other years means "more than".

1 Adjusted to 2004 dollars based on U.S. Department of Commerce Implicit Price Deflator for Construction.

2 Considered too high in 1915 reference.

3 Using 1915 cost adjustment - none available prior to 1915.

L Normalization reflects inflation, changes in personal wealth and coastal county population to 2004 (Pielke and Landsea 1998.)

Table 13b. As in Table 13a, but for the thirty deadliest years from 1851-2004 and costliest years from 1900 to 2004.

	Ranked on Deaths		Ranked on Unadjusted Damage		Ranked on Adjusted[1] Damage		Ranked by Normalized[L] Damage	
	Year	Deaths	Year	($ Millions)	Year	($ Millions)	Year	($ Millions)
1	1900	8,000 [+]	1 2004	45,000	1 2004	45,000	1 1926	104,908
2	1893	~ 3,000 [s]	2 1992	26,500	2 1992	34,955	2 2004	45,000
3	1928	2,500	3 1989	7,670	3 1989	10,672	3 1992	43,152
4	1881	700	4 1999	5,532	4 1965	8,664	4 1900	37,541
5	1915	550	5 2001	5,260	5 1972	8,603	5 1915	33,344
6	1935	414	6 1998	4,344	6 1969	6,994	6 1944	33,133
7	1926	408	7 1985	4,000	7 1979	6,574	7 1938	23,464
8	1909	406	8 1995	3,723	8 1955	6,562	8 1954	22,844
9	1957	400	9 1996	3,600	9 1985	6,450	9 1928	19,457
10	1906	298	10 2003	3,600	10 2001	6,132	10 1955	17,204
11	1919	287	11 1979	3,045	11 1938	5,971	11 1965	16,557
12	1969	256	12 1972	2,100	12 1998	5,817	12 1960	15,918
12	1938	256	13 1983	2,000	13 1999	5,737	13 1947	15,196
14	1955	218	14 1991	1,500	14 1954	5,140	14 1969	14,298
15	1954	193	15 1965	1,445	15 1995	4,369	15 1972	13,978
16	1972	122	16 1969	1,421	16 1996	4,129	16 1989	13,436
17	1916	107	17 2002	1,220	17 2003	3,892	17 1979	11,264
18	1965	75	18 1955	985	18 1983	3,422	18 1945	9,958
19	1960	65	19 1994	973	19 1964	3,174	19 1903	9,730
20	1944	64	20 1954	756	20 1915	2,592 [3]	20 1961	9,340
21	1933	63	21 1964	515	21 1961	2,588	21 1964	9,193
22	1999	62	22 1975	490	22 1944	2,539	22 1949	8,707
23	2004	60	23 1970	454	23 1960	2,464	23 1985	8,567
24	1989	56	24 1961	414	24 1926	2,186	24 1919	7,543
25	1966	54	25 1960	396	25 1970	2,109	25 2001	6,254
26	1947	53	26 1938	306	26 1991	2,005	26 1999	6,222
27	1940	51	27 1980	300	27 1975	1,489	27 1906	5,739
28	1964	49	28 1971	213	28 1947	1,454	28 1998	5,484
29	1961	46	29 1967	200	29 2002	1,383	29 1983	5,289
30	2001	45	30 1944	165	30 1900	1,235 [2]	30 1916	5,077

[+] Could have been as high as 12,000.

[1] Adjusted to 2004 dollars based on U.S. Department of Commerce Implicit Price Deflator for Construction.

[2] Considered too high in 1915 reference.

[3] Using 1915 cost adjustment - none available prior to 1915.

[s] Could include offshore losses

[L] Landsea normalization reflects inflation, changes in personal wealth and coastal county population to 2004 (Pielke and Landsea 1998.)

Table 14. Deadliest and Costliest Hurricanes from 1900 to 2004 to affect Hawaii, Puerto Rico and the U.S. Virgin Islands.

Name	Date	Island or CPA	Damage ($000) Unadjusted	Adjusted for Inflation	Deaths	Max Wind (Mph)	Min P (Mb)
Mokapu Cyclone	Aug 19,1938	25 mi NE Oahu	Unk	Unk	Unk	Unk	Unk
Hiki	Aug 15,1950	100 mi NE Hawaii	Unk	Unk	Unk	Unk	Unk
Nina	Dec 02,1957	100 mi SW Kauai	200	1,227	4	90	965
Dot	Aug 06,1959	Kauai	6,000	37,332	0	115	955
Iwa	Nov 23,1982	25 mi NW Kauai	312,000	543,651	1	90	964
Iniki	Sep 11,1992	Kauai	1,800,000	2,374,290	4	130	950
San Hipolito	Aug 22,1916	Puerto Rico	1,000	26,919	1	98	988
San Liborio	Jul 23,1926 [1]	SW Puerto Rico	5,000	77,591	25	81	~985
San Felipe	Sep 13,1928	Puerto Rico	85,000	1,319,050	312	161	Unk
San Nicolas	Sep 10,1931 [1]	Puerto Rico	200	3,298	2	121	Unk
San Ciprian	Sep 26,1932 [1]	USVI, PR	30,000	494,644	225	98	948
San Mateo	Sep 21,1949	St. Croix	Unk	Unk	Unk	81	~985
Santa Clara (*Betsy*)	Aug 12,1956	Puerto Rico	40,000	252,450	16	92	991
Donna	Sep 05,1960 [1]	PR & St. Thomas	Unk	Unk	107	132	958
Eloise (T.S.)	Sep 15,1975 [1]	Puerto Rico	Unk	Unk	44	40	1007
David	Aug 30,1979 [2]	S. of Puerto Rico	Unk	Unk	Unk	173	924
Frederic (T.S.)	Sep 04,1979 [2]	Puerto Rico	125,000	269,855	7	58	1000
Hugo	Sep 18,1989	USVI, PR	1,000,000	1,391,403	5	138	940
Marilyn	Sep 16,1995	USVI, E. PR	1,500,000	1,760,298	8	109	952
Hortense	Sep 10,1996	SW Puerto Rico	500,000	573,500	18	81	989
Georges	Sep 21,1998	USVI & PR	1,800,000	1,945,900	0	115	968
Lenny	Nov 17,1999	USVI & PR	330,000	342,233	0	155	933

[1] Effects continued into the following day. [2] Damage and Casualties from David and Frederic are combined.

(12) **Are there hurricane cycles?** Figures 1 through 16 show the landfalling portion of the tracks of major hurricanes that have struck the United States between 1851-2004. The reader might note the tendency for the major hurricane landfalls to cluster in certain areas during certain decades. Another interesting point is the tendency for this clustering to occur in the latter half of individual decades in one area and in the first half of individual decades in another area. During the very active period of the thirties this clustering is not apparent.

A comparison of twenty-year periods beginning in 1851 indicates that the major hurricanes tended to be in Gulf Coast states before 1891, then favored Florida and the W. Gulf until 1911, shifting to the eastern Gulf Coast states and Florida during the next twenty years, then to Florida and the Atlantic Coast states during the 1940s-1950s, and back to the western Gulf Coast states in the following twenty-year period.

CONCLUSIONS

In virtually every coastal city from Texas to Maine, the present Tropical Prediction Center Director (Max Mayfield) former National Hurricane Center Directors have stated that the United States is building toward its next hurricane disaster. The population growth and low hurricane experience levels indicated in Hebert et al. (1984), together with updated statistics presented by Jarrell et al. (1992) form the basis for their statements. The areas along the United States Gulf and Atlantic coasts where most of this country's hurricane related fatalities have occurred are also now experiencing the country's most significant growth in population. This situation, in combination with continued building along the coast, will lead to serious problems for many areas in hurricanes. Because it is likely that people will always be attracted to live along the shoreline, a solution to the problem lies in education and preparedness as well as long-term policy and planning.

The message to coastal residents is this: Become familiar with what hurricanes can do, and when a hurricane threatens your area, increase your chances of survival by moving away from the water until the hurricane has passed! Unless this message is clearly understood by coastal residents through a thorough and continuing preparedness effort, disastrous loss of life is inevitable in the future.

Acknowledgments: Richard Pasch and Max Mayfield made helpful suggestions. Paul Hebert, J.G. Taylor and R.A. Case, co-authors of previous versions of this paper, are recognized for their enduring contributions to this work. Lenworth Woolcock drafted the 19th century figures and Joan David drafted the 20th and 21st century figures.

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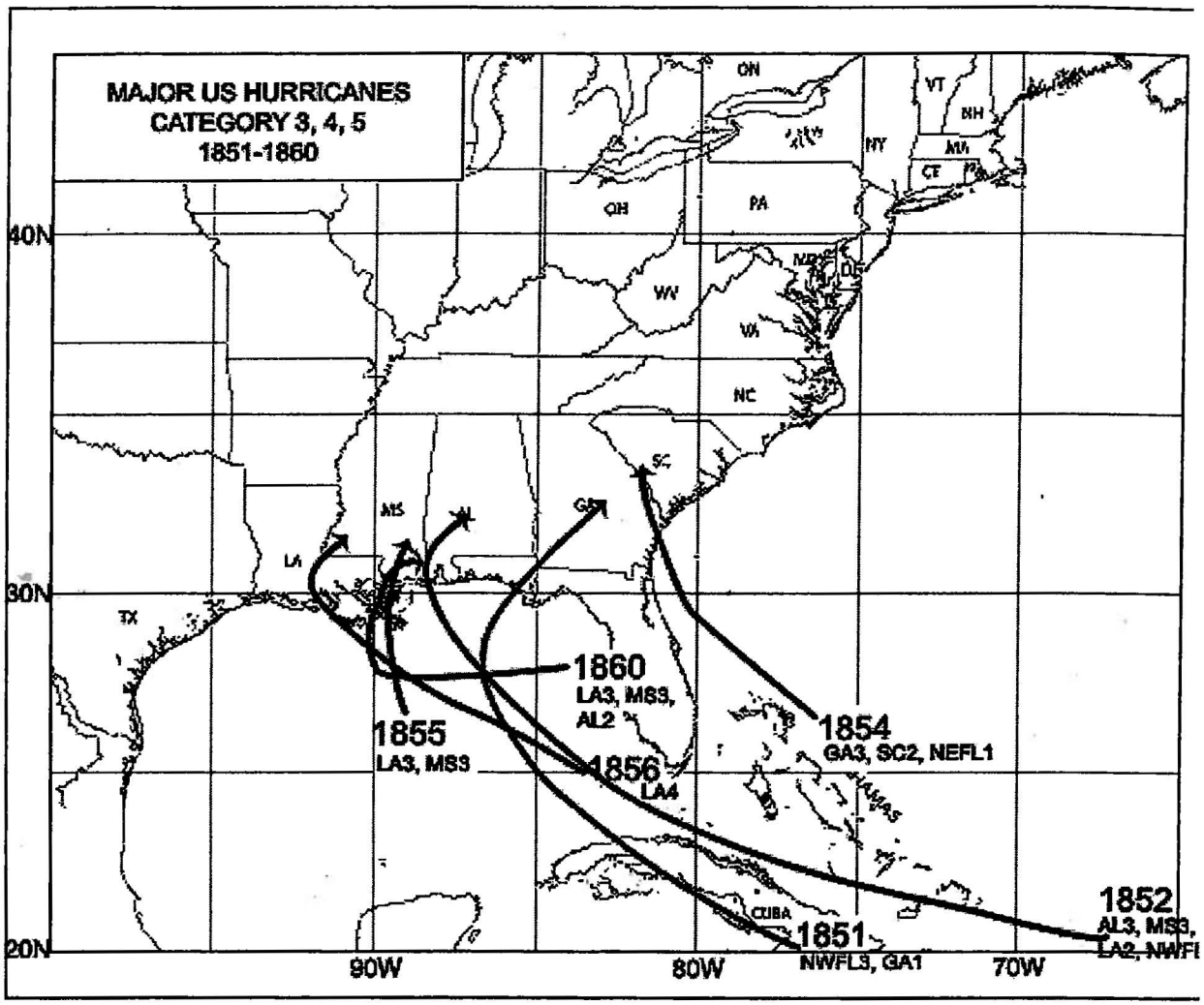


Figure 1. Landfalling United States major hurricanes during the period 1851-1860.

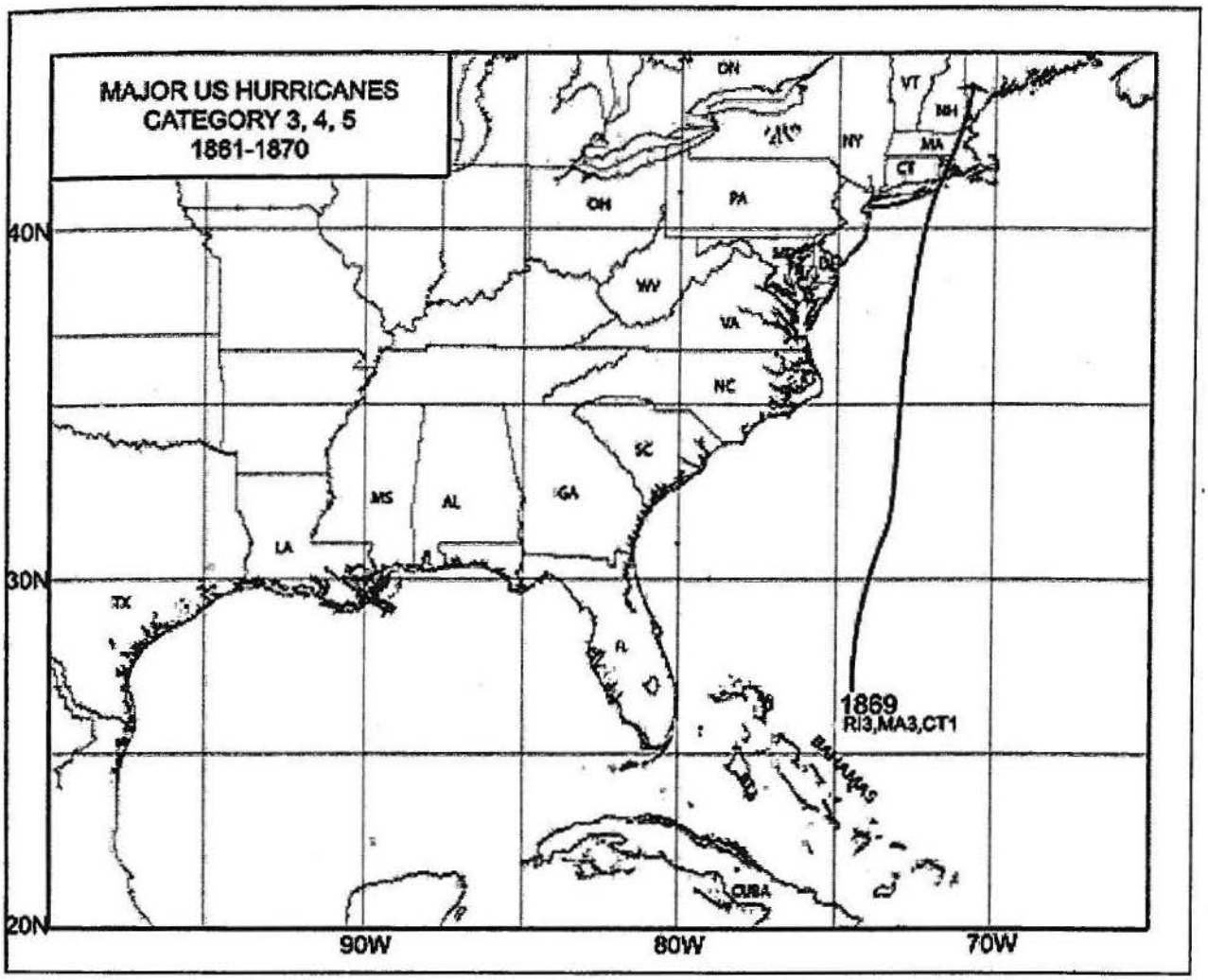


Figure 2. Landfalling United States major hurricanes during the period 1861-1870.

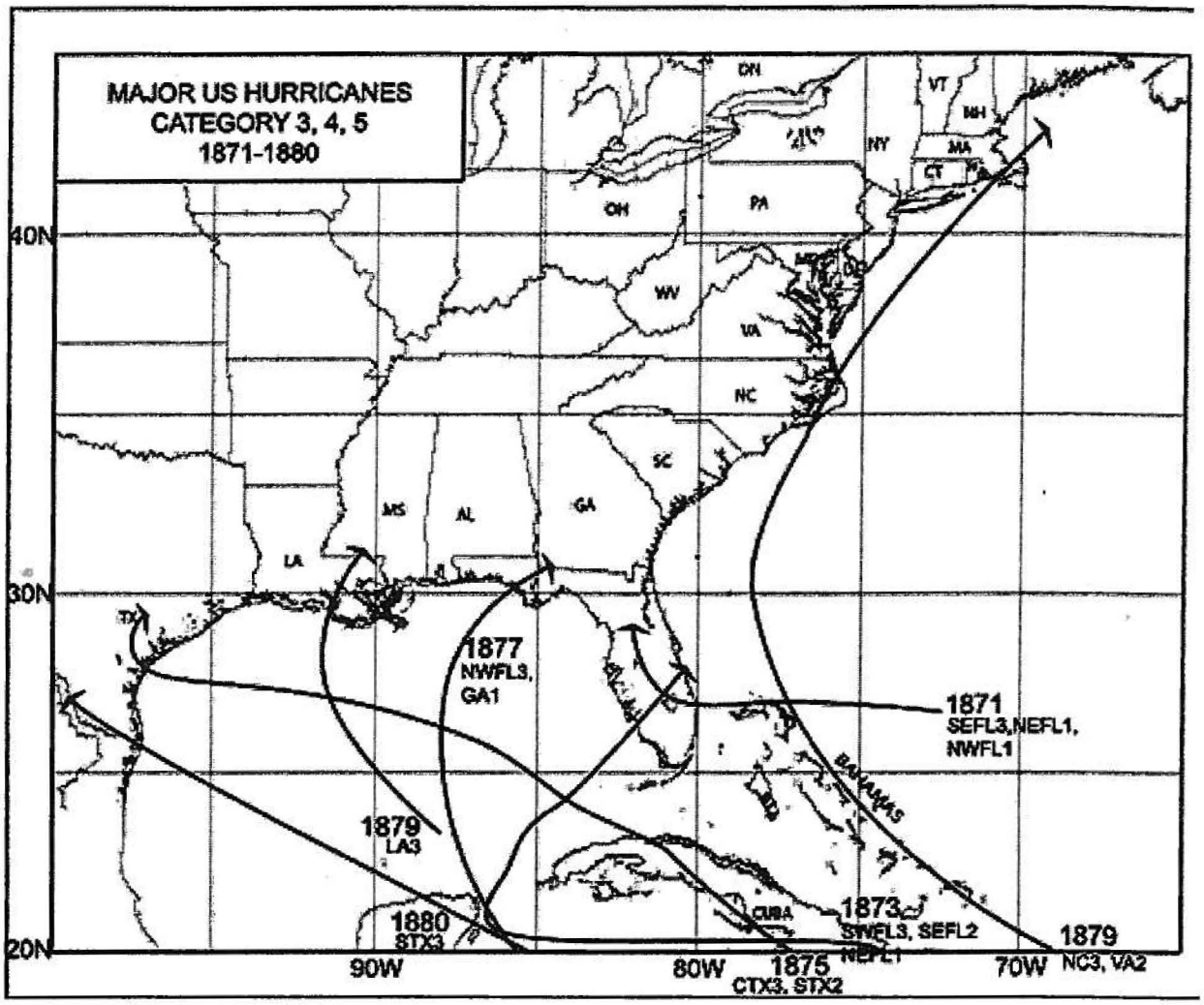


Figure 3. Landfalling United States major hurricanes during the period 1871-1880.

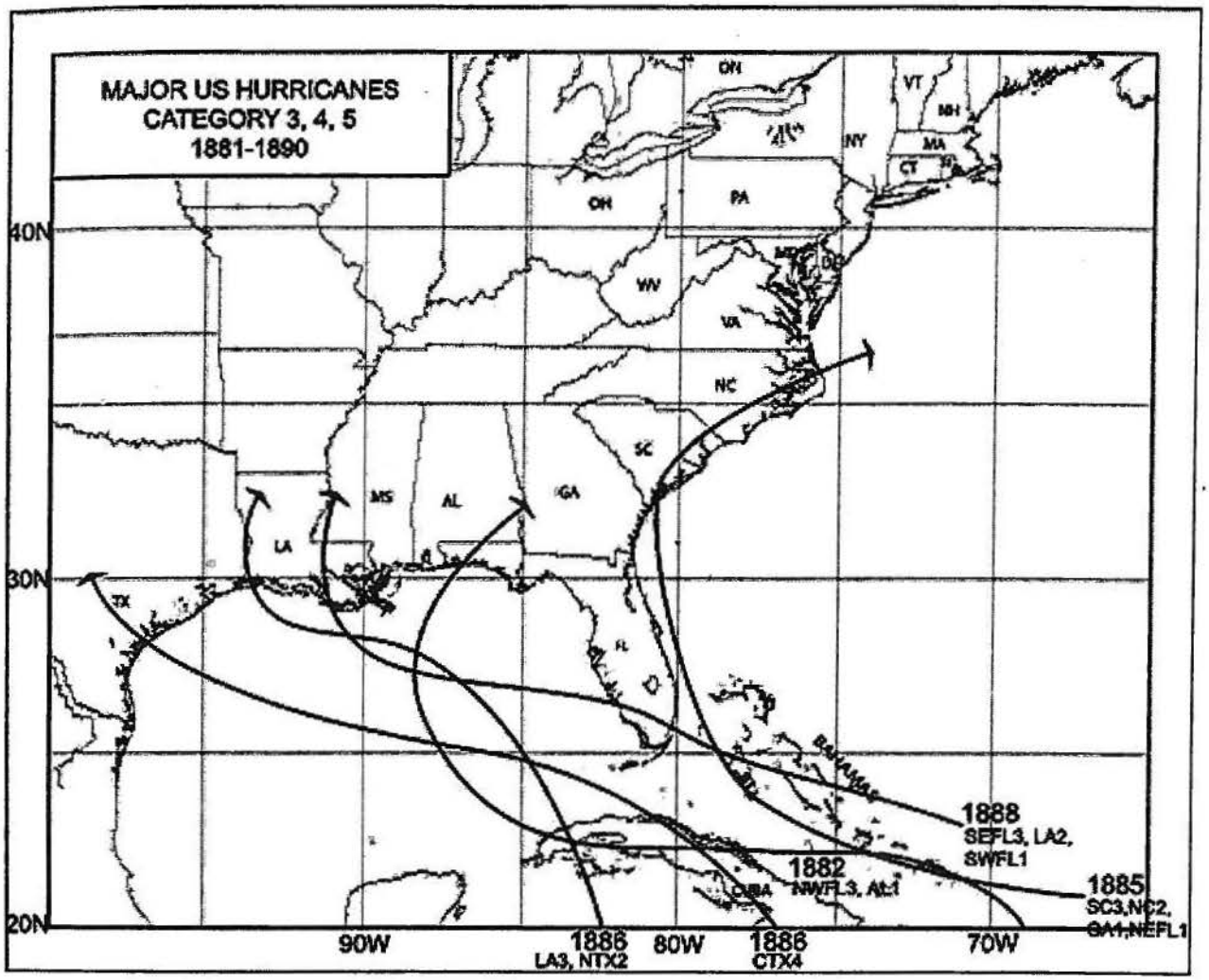


Figure 4. Landfalling United States major hurricanes during the period 1881-1890.

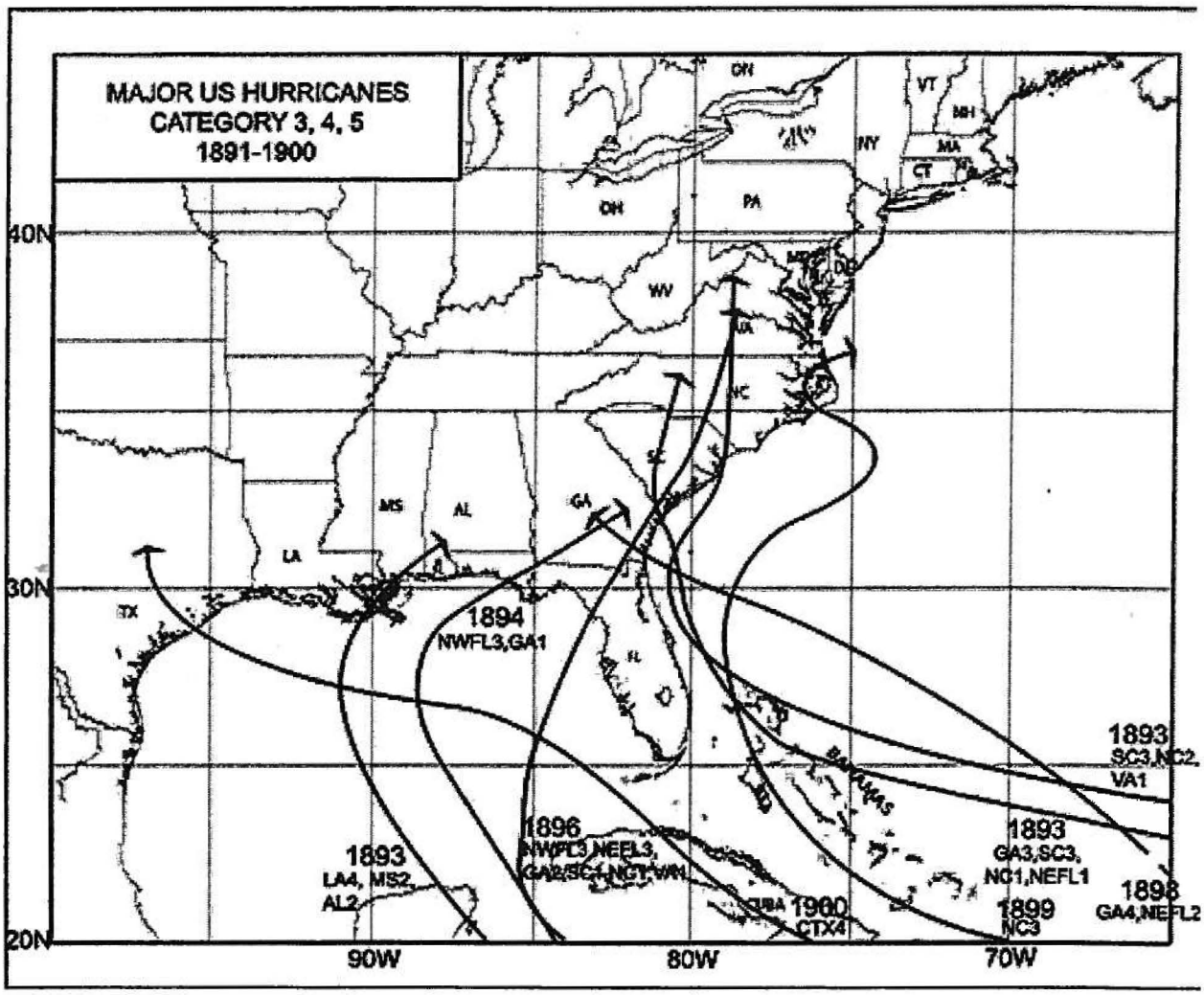


Figure 5. Landfalling United States major hurricanes during the period 1891-1900.

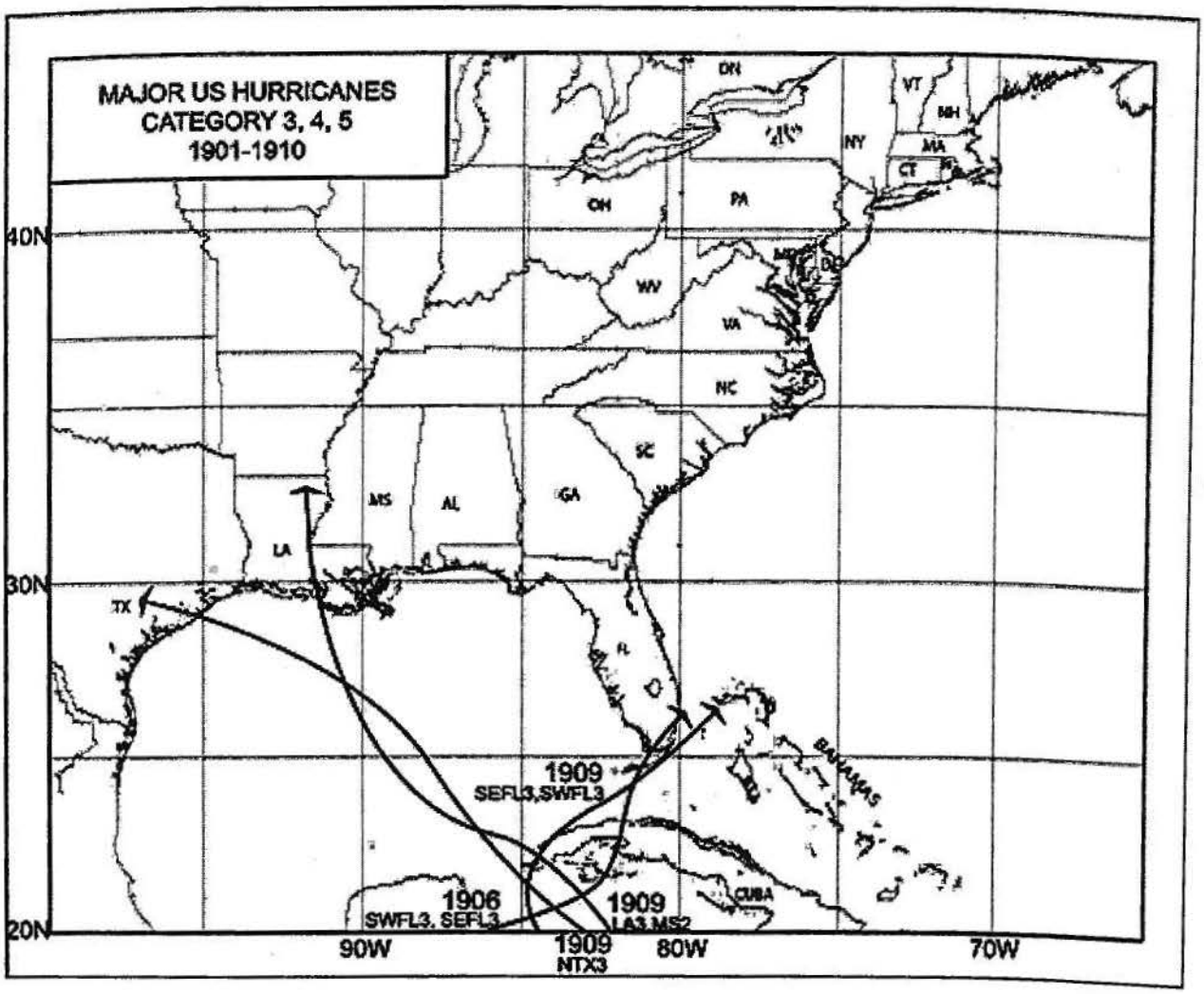


Figure 6. Landfalling United States major hurricanes during the period 1901-1910.

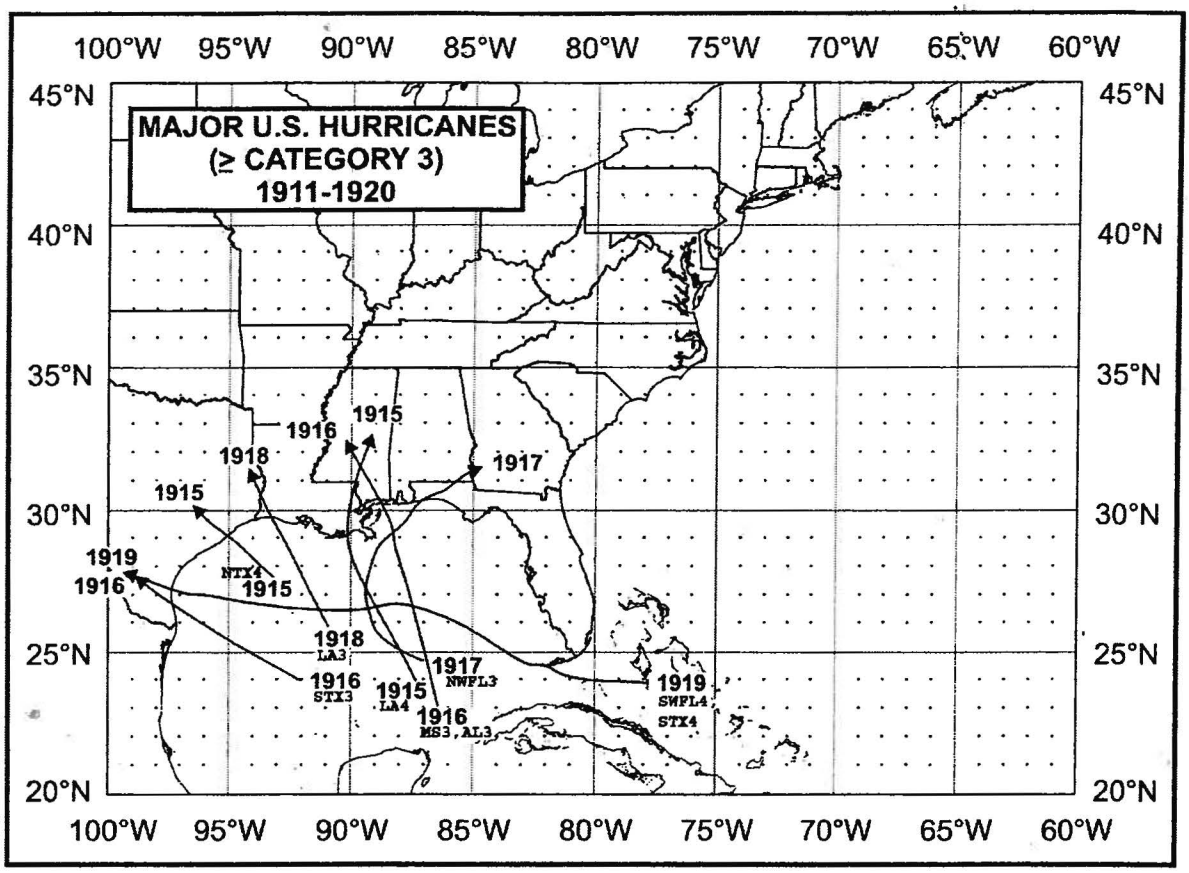


Figure 7. Landfalling United States major hurricanes (stronger than or equal to a category 3 during the period 1911-1920.

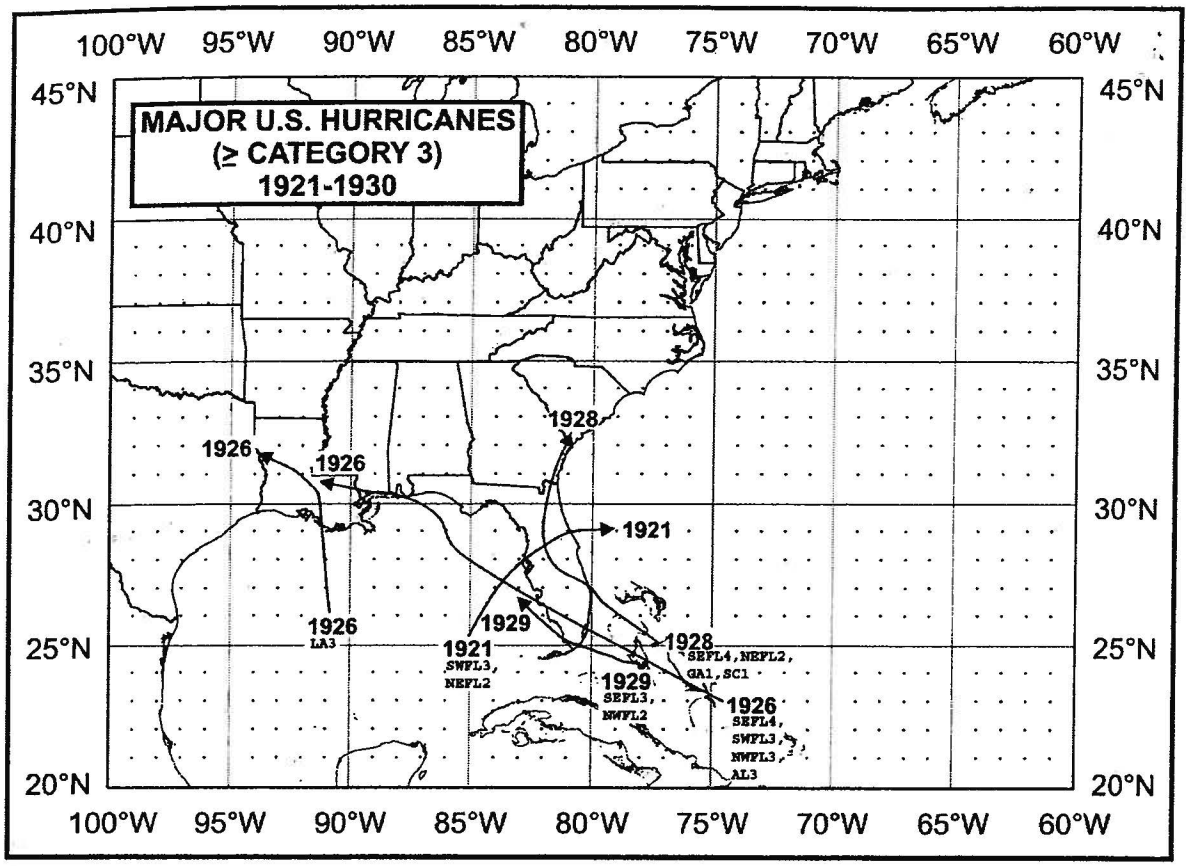


Figure 8. Landfalling United States major hurricanes (stronger than or equal to a category 3) during the period 1921-1930.

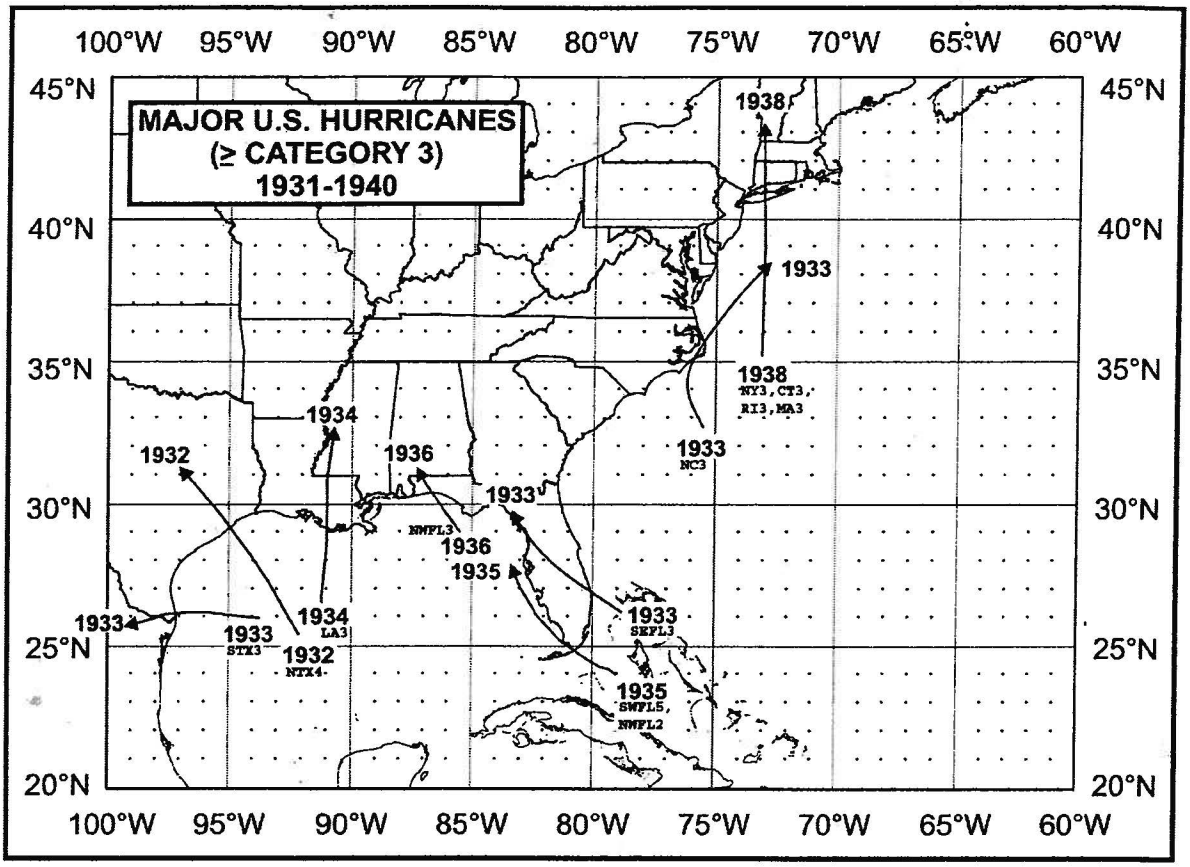


Figure 9. Landfalling United States major hurricanes (stronger than or equal to a category 3 during the period 1931-1940.

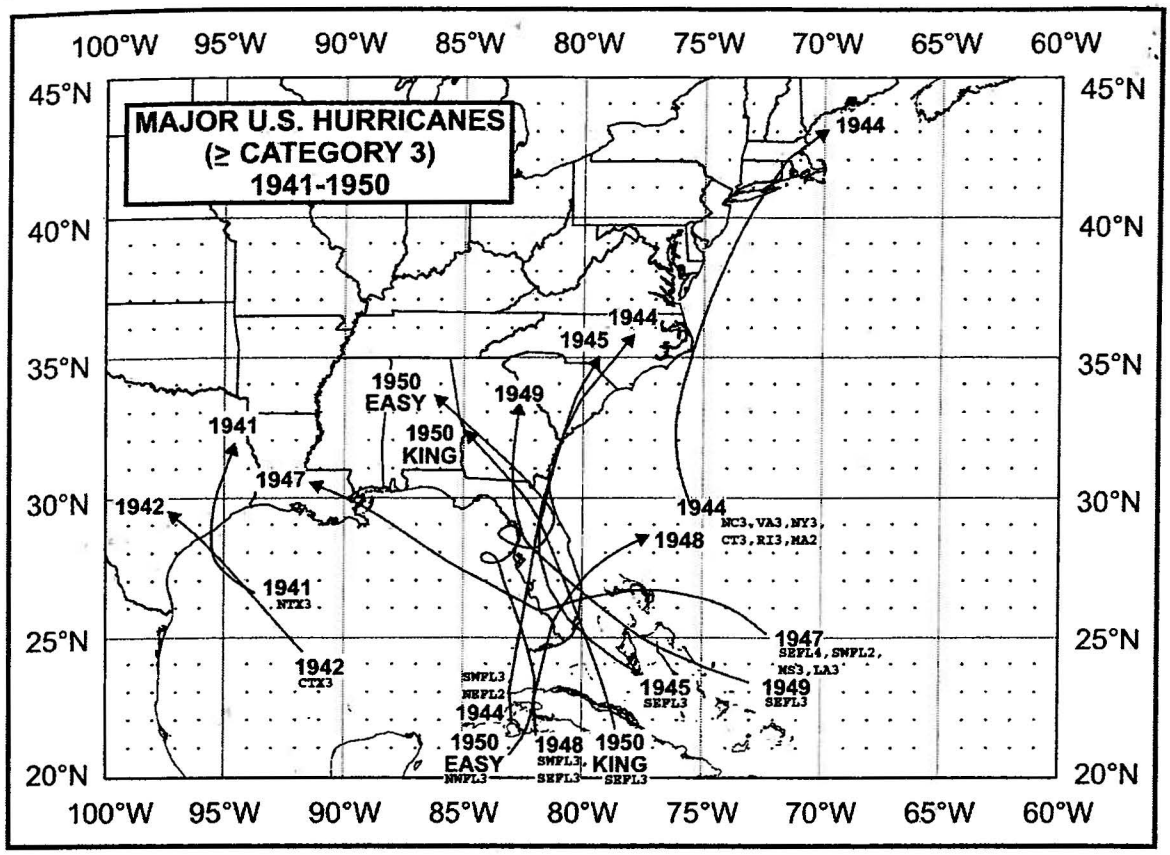


Figure 10. Landfalling United States major hurricanes (stronger than or equal to a category 3) during the period 1941-1950.

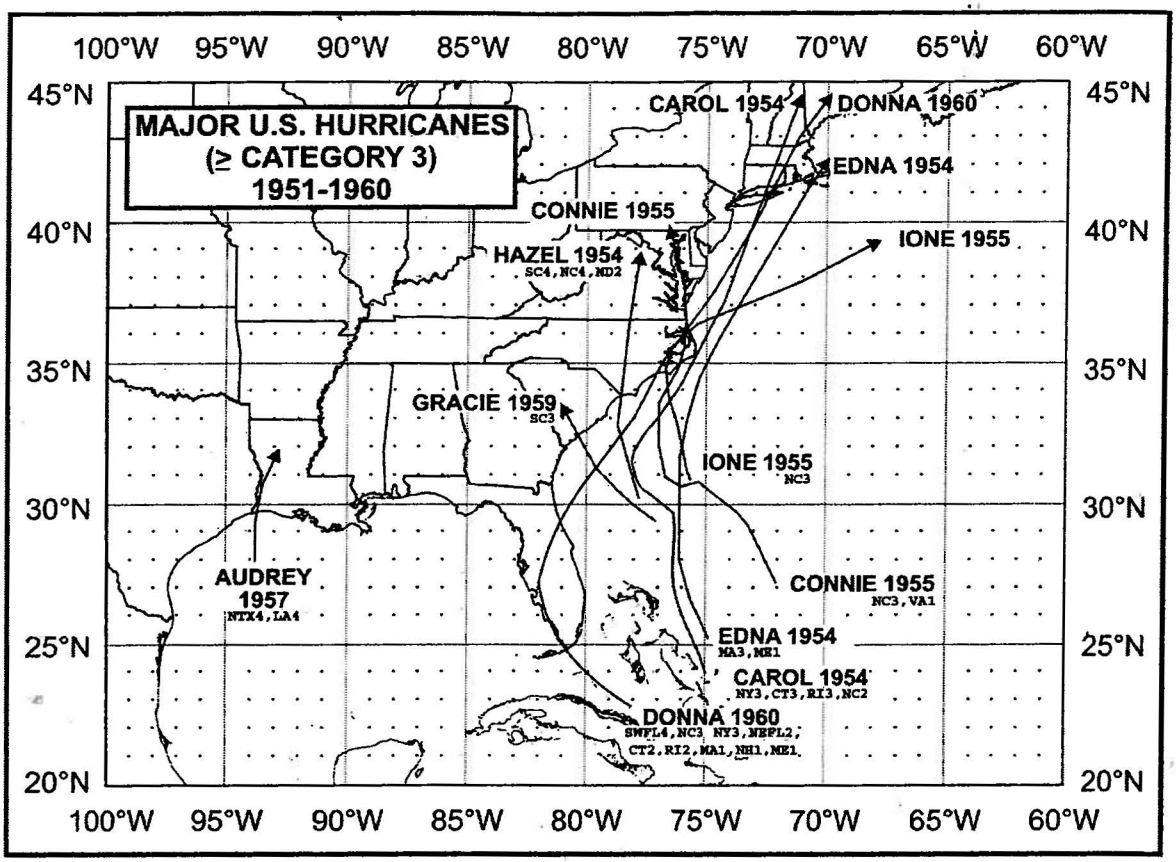
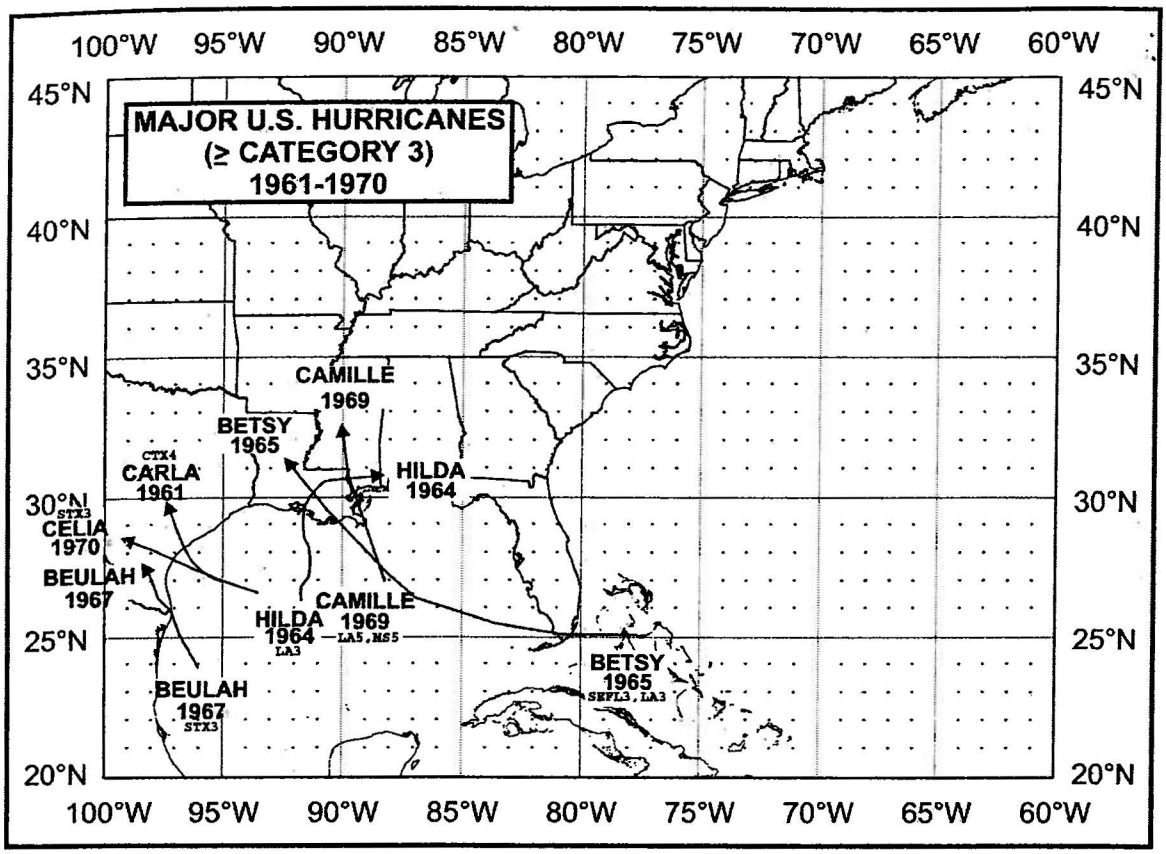


Figure 11. Landfalling United States major hurricanes (stronger than or equal to a category during the period 1951-1960.



3) Figure 12. Landfalling United States major hurricanes (stronger than or equal to a category 3) during the period 1961-1970.

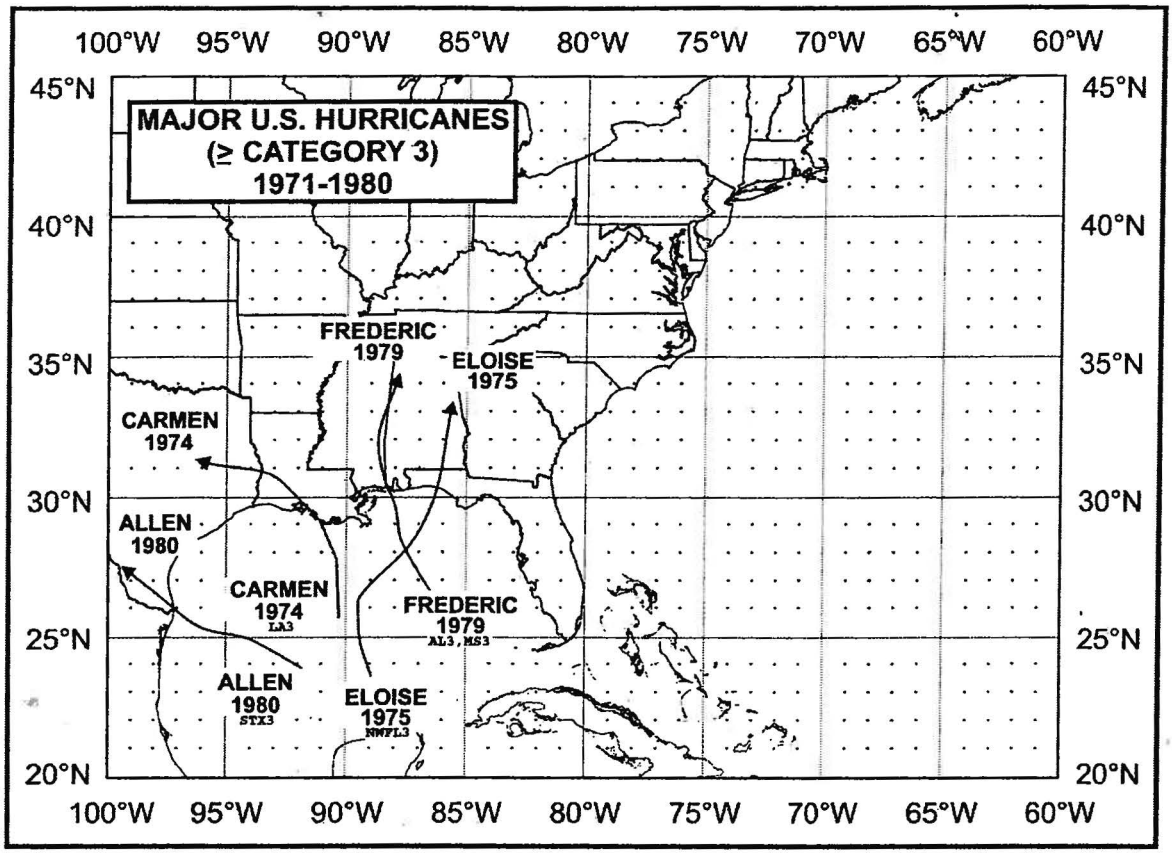
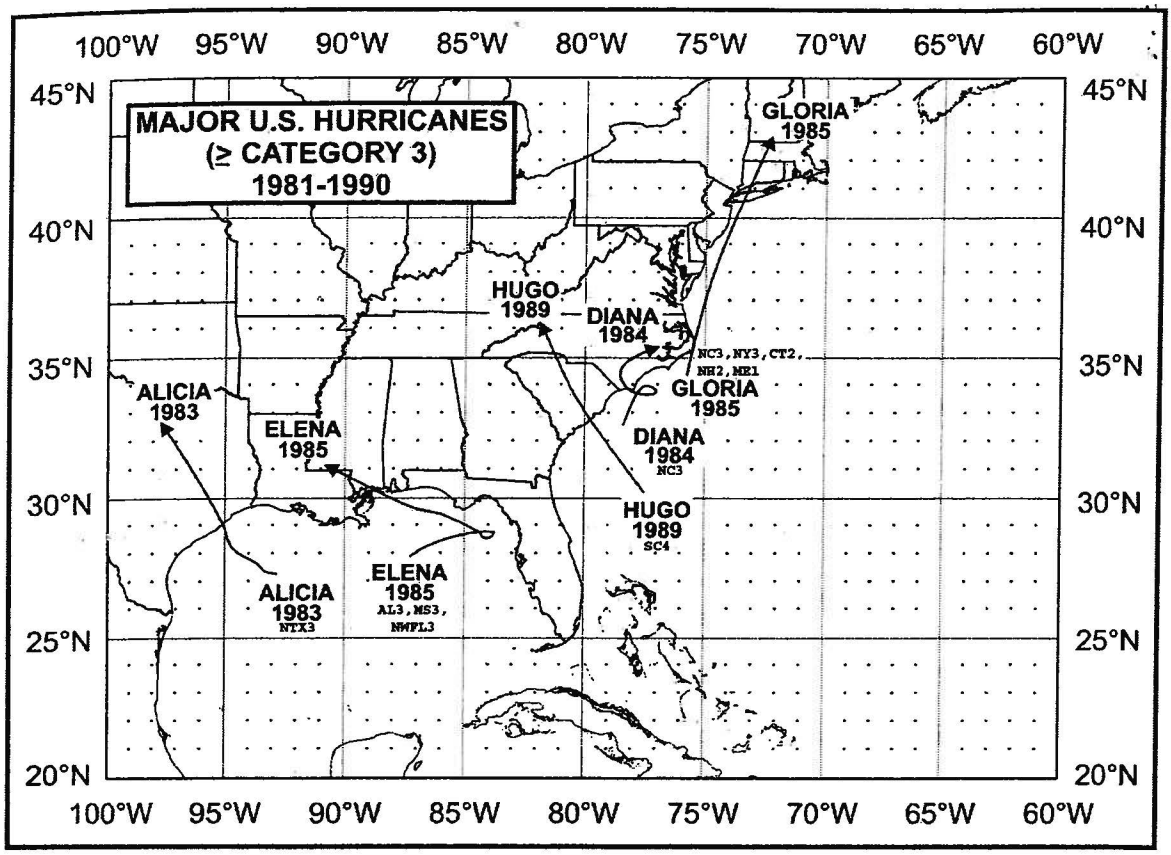


Figure 13. Landfalling United States major hurricanes (stronger than or equal to a category
during the period 1971-1980.



3) Figure 14. Landfalling United States major hurricanes (stronger than or equal to a category 3) during the period 1981-1990.

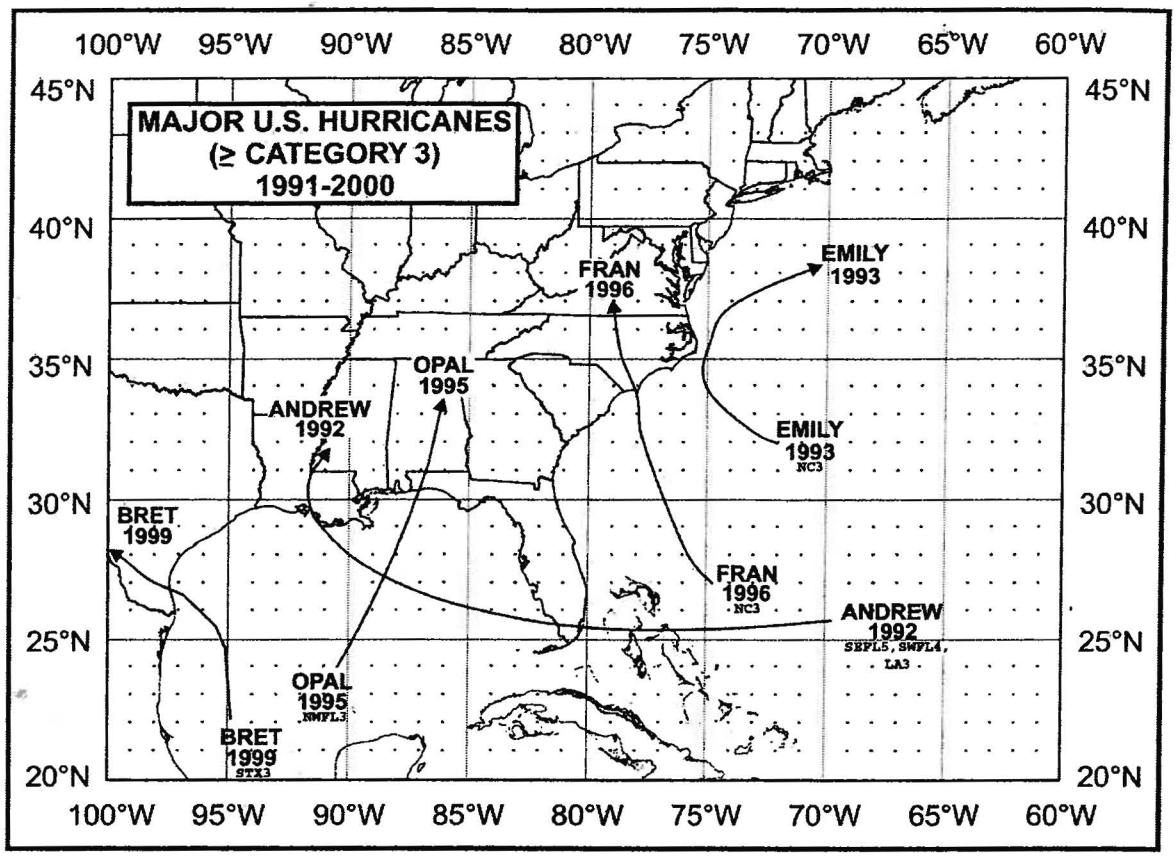


Figure 15. Landfalling United States major hurricanes (stronger than or equal to a category during the period 1991-2000.

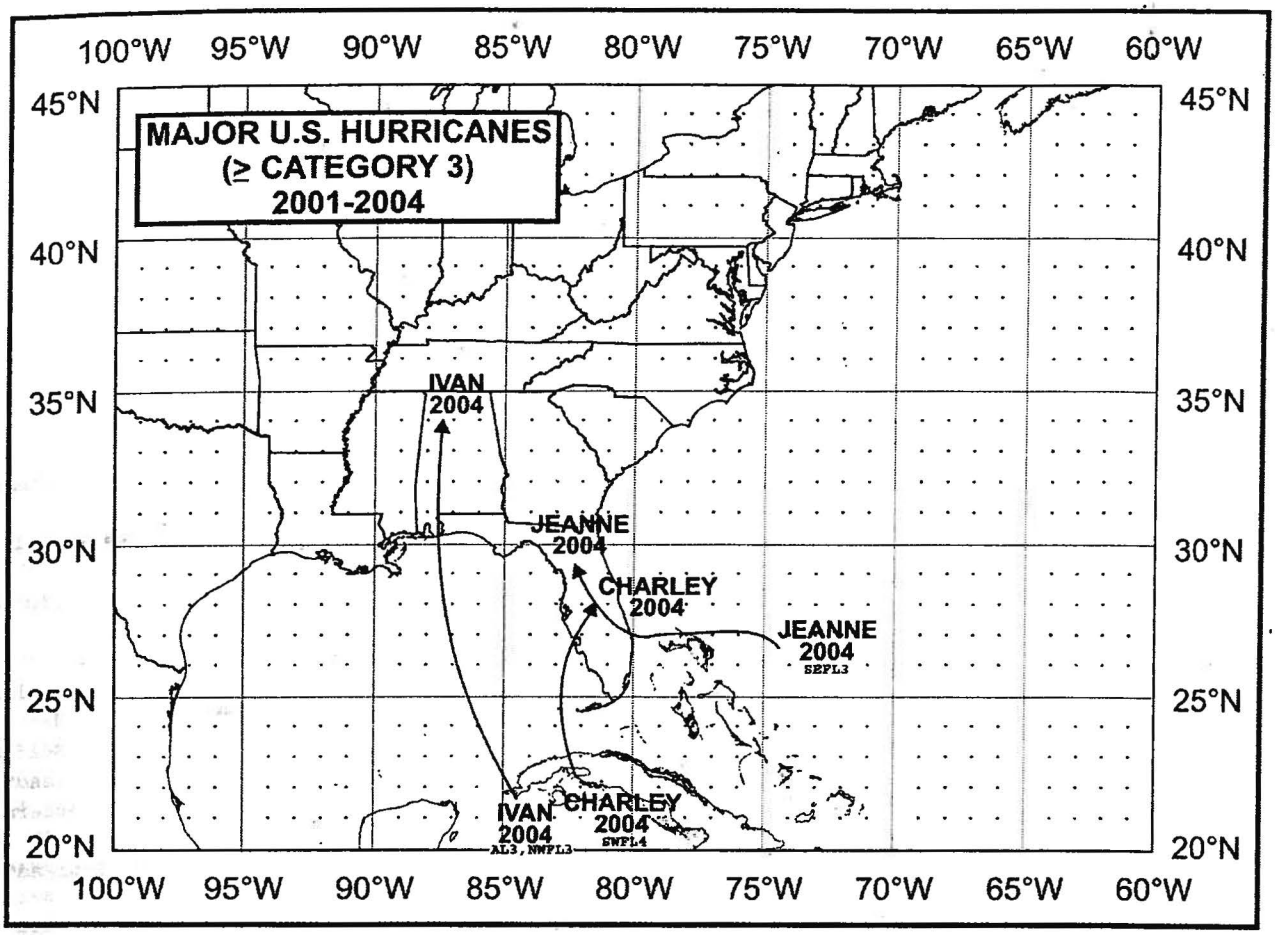


Figure 16. Landfalling United States major hurricanes (stronger than or equal to a category 3) during the period 2001-2004.

Appendix A: Chronological List of All Hurricanes which Affected the Continental United States: 1851-2004. (Updated from Jarrell et al. 1992 and reflecting official HURDAT reanalysis changes through 1914. Note that from 1915 through 1979, no official wind speed estimates are currently available.)

Year	Month	States Affected and Category by States	Highest Saffir-Simpson U.S. Category	Central Pressure	Max. Winds (kt)	Name
1851	Jun	TX, C1	1	977 mb	80	-----
1851	Aug	FL, NW3; GA, 1	3	960	100	"Great Middle Florida
1852	Aug	FL, SW1	1	977	80	-----
1852	Aug	AL, 3; MS, 3; LA, 2; FL, NW1	3	961	100	"Great Mobile"
1852	Sep	FL, SW1	1	985	70	-----
1852	Oct	FL, NW2; GA, 1	2	969	90	"Middle Florida"
1853	Oct *	GA, 1	1	965	70	-----
1854	Jun	TX, S1	1	985	70	-----
1854	Sep	GA, 3; SC, 2; FL, NE1	3	950	100	"Great Carolina"
1854	Sep	TX, C2	2	969	90	"Matagorda"
1855	Sep	LA, 3; MS, 3	3	950	110	"Middle Gulf Shore"
1856	Aug	LA, 4	4	934	130	"Last Island"
1856	Aug	FL, NW2; AL, 1; GA, 1	2	969	90	"Southeastern States"
1857	Sep &	NC, 1	1	961	80	-----
1858	Sep	NY, 1; CT, 1; RI, 1; MA, 1	1	976	80	"New England"
1859	Sep	AL, 1; FL, NW1	1	985	70	-----
1860	Aug	LA, 3; MS, 3; AL, 2	3	950	110	-----
1860	Sep	LA, 2; MS, 2; AL, 1	2	969	90	-----
1860	Oct	LA, 2	2	969	90	-----
1861	Aug *	FL, SW1	1	970	70	"Key West"
1861	Sep	NC, 1	1	985	70	"Equinoctial"
1861	Nov	NC, 1	1	985	70	"Expedition"
1865	Sep	LA, 2; TX, N1	2	969	90	"Sabine River-Lake Calcasieu"
1865	Oct	FL, SW2; FL, SE1	2	969	90	-----
1866	Jul	TX, C2	2	969	90	-----
1867	Jun	SC, 1	1	985	70	-----
1867	Oct	LA, 2; TX, S1, N1; FL, NW1	2	969	90	"Galveston"
1869	Aug	TX, C2	2	969	90	"Lower Texas Coast"
1869	Sep	LA, 1	1	985	70	-----
1869	Sep	RI, 3; MA, 3; NY, 1; CT, 1	3	963	100	"Eastern New England"
1869	Oct &	ME, 2; MA, 1	2	965	90	"Saxby's Gale"
1870	Jul	AL, 1	1	985	70	"Mobile"
1870	Oct *	FL, SW1, SE1	1	970	70	"Twin Key West (I)"
1870	Oct	FL, SW1	1	977	80	"Twin Key West (II)"
1871	Aug	FL, SE3, NE1, NW1	3	955	100	-----
1871	Aug	FL, SE2, NE1	2	965	90	-----
1871	Sep	FL, NW1	1	985	70	-----
1873	Sep	FL, NW1	1	985	70	-----
1873	Oct	FL, SW3, SE2, NE1	3	959	100	-----
1874	Sep	FL, NW1; SC, 1; NC, 1	1	985	70	-----
1875	Sep	TX, C3, S2	3	960	100	-----
1876	Sep	NC, 1; VA, 1	1	980	80	-----

1876	Oct	FL, SW2, SE1	2	973	90	-----
1877	Sep	LA, 1; FL, NW1	1	985	70	-----
1877	Oct	FL, NW3; GA, 1	3	960	100	-----
1878	Sep	FL, SW2, NE1; SC, 1; GA, 1	2	970	90	-----
1878	Oct	NC, 2; VA, 1; MD, 1; DE, 1; NJ, 1; PA, 1	2	963	90	-----
1879	Aug	NC, 3; VA, 2	3	971	100	-----
1879	Aug	TX, N2; LA, 2	2	964	90	-----
1879	Sep	LA, 3	3	950	110	-----
1880	Aug #	TX, S3	3	931	110	-----
1880	Aug	FL, SE2, NE1, NW1	2	972	90	-----
1880	Sep	NC, 1	1	987	70	-----
1880	Oct	FL, NW1	1	985	70	-----
1881	Aug	GA, 2; SC, 1	2	970	90	-----
1881	Sep	NC, 2	2	975	90	-----
1882	Sep	FL, NW3; AL, 1	3	949	100	-----
1882	Sep	LA, 2; TX, N1	2	969	90	-----
1882	Oct	FL, NW1	1	985	70	-----
1883	Sep	NC, 2; SC, 1	2	965	90	-----
1885	Aug	SC, 3; NC, 2; GA, 1; FL, NE1	3	953	100	-----
1886	Jun	TX, N2; LA, 2	2	973	85	-----
1886	Jun	FL, NW2; GA, 1	2	973	85	-----
1886	Jun	FL, NW2	2	973	85	-----
1886	Jul	FL, NW1	1	985	70	-----
1886	Aug	TX, C4	4	925	135	"Indianola"
1886	Sep #	TX, S1, C1	1	973	80	-----
1886	Oct	LA, 3; TX, N2	3	955	105	-----
1887	Jul	FL, NW1	1	981	75	-----
1887	Aug *	NC, 1	1	946	65	-----
1887	Sep	TX, S2	2	973	85	-----
1887	Oct	LA, 1	1	981	75	-----
1888	Jun	TX, C1	1	985	70	-----
1888	Aug	FL, SE3, SW1; LA2	3	945	110	-----
1888	Sep &	MA, TS	TS	985	55	-----
1888	Oct	FL, NW2, NE1	2	970	95	-----
1889	Sep	LA, 1	1	985	70	-----
1891	Jul	TX, C1, N1	1	977	80	-----
1891	Aug	FL, SE1	1	985	70	-----
1893	Aug	NY, 1; VA, 1	1	986	75	"Midnight Storm"
1893	Aug	GA, 3; SC, 3; NC, 1; FL, NE1	3	954	100	"Sea Islands"
1893	Sep	LA, 2	2	973	85	-----
1893	Oct	LA, 4; MS, 2; AL, 2	4	948	115	"Chenier Caminanda"
1893	Oct	SC, 3; NC, 2; VA, 1	3	955	105	-----
1894	Sep	FL, SW2, NE1; SC, 1; VA, 1	2	975	90	-----
1894	Oct	FL, NW3; GA, 1; NY, 1; RI, 1	3	955	105	-----
1895	Aug #	TX, S1	1	973	65	-----
1896	Jul	FL, NW2	2	973	85	-----
1896	Sep	RI, 1; MA, 1	1	985	70	-----
1896	Sep	FL, NW3, NE3; GA, 2; SC, 1; NC, 1; VA, 1	3	960	110	-----
1897	Sep	LA, 1; TX, N1	1	981	75	-----
1898	Aug	FL, NW1	1	985	70	-----
1898	Aug	GA, 1; SC, 1	1	980	75	-----
1898	Oct	GA, 4; FL, NE2	4	938	115	-----
1899	Aug	FL, NW2	2	979	85	-----
1899	Aug	NC, 3	3	945	105	-----
1899	Oct	NC, 2; SC, 2	2	955	95	-----

1900	Sep	TX, N4	4	936	125	"Galveston"
1901	Jul	NC, 1	1	983	70	-----
1901	Aug	LA, 1; MS, 1; AL, 1	1	973	80	-----
1903	Sep	FL, SE1, NW1	1	976	80	-----
1903	Sep	NJ, 1; DE, 1	1	990	70	-----
1904	Sep	SC, 1	1	985	70	-----
1904	Oct	FL, SE1	1	985	70	-----
1906	Jun	FL, SW1, SE1	1	979	75	-----
1906	Sep	SC, 1; NC, 1	1	977	80	-----
1906	Sep	MS, 2; AL, 2; FL, NW2; LA, 1	2	958	95	-----
1906	Oct	FL, SW3, SE3	3	953	105	-----
1908	May &	NC, TS	TS	989	55	-----
1908	Jul	NC, 1	1	985	70	-----
1909	Jun	TX, S2	2	972	85	-----
1909	Jul	TX, N3	3	959	100	"Velasco"
1909	Aug #	TX, S1	1	955	65	-----
1909	Sep	LA, 3; MS, 2	3	952	105	"Grand Isle"
1909	Oct	FL, SW3, SE3	3	957	100	-----
1910	Sep	TX, S2	2	965	95	-----
1910	Oct	FL, SW2	2	955	95	-----
1911	Aug	FL, NW1; AL,1	1	985	70	-----
1911	Aug	SC, 2; GA, 1	2	972	85	-----
1912	Sep	AL, 1; FL, NW1	1	988	65	-----
1912	Oct	TX, S2	2	973	85	-----
1913	Jun	TX, S1	1	988	65	-----
1913	Sep	NC, 1	1	976	75	-----
1913	Oct	SC, 1	1	989	65	-----
1915	Aug	TX, N4	4	945	----	"Galveston"
1915	Sep	FL, NW1	1	988	----	-----
1915	Sep	LA, 4	4	931	----	"New Orleans"
1916	Jul	MS, 3; AL, 3	3	948	----	-----
1916	Jul	MA, 1	1	-----	----	-----
1916	Jul	SC, 1	1	980	----	-----
1916	Aug	TX, S3	3	948	----	-----
1916	Oct	AL, 2; FL, NW2	2	972	----	-----
1916	Nov	FL, SW1	1	-----	----	-----
1917	Sep	FL, NW3	3	958	----	-----
1918	Aug	LA, 3	3	955	----	-----
1919	Sep	FL, SW4; TX, S4	4	927	----	-----
1920	Sep	LA, 2	2	975	----	-----
1920	Sep	NC, 1	1	-----	----	-----
1921	Jun	TX, C2	2	979	----	-----
1921	Oct	FL, SW3, NE2	3	952	----	"Tampa Bay"
1923	Oct	LA, 1	1	985	----	-----
1924	Sep	FL, NW1	1	985	----	-----
1924	Oct	FL, SW1	1	980	----	-----
1925	No-De	FL, SW1	1	-----	----	-----
1926	Jul	FL, NE2	2	967	----	-----
1926	Aug	LA, 3	3	955	----	-----
1926	Sep	FL, SE4, SW3, NW3; AL, 3	4	935	----	"Great Miami"
1928	Aug	FL, SE2	2	-----	----	-----
1928	Sep	FL, SE4, NE2; GA, 1; SC, 1	4	929	----	"Lake Okeechobee"
1929	Jun	TX, C1	1	982	----	-----
1929	Sep	FL, SE3, NW2	3	948	----	-----
1932	Aug	TX, N4	4	941	----	"Freeport"

1932	Sep	AL, 1	1	979	----	-----
1933	Aug	TX, S2; FL, SE1	2	975	----	-----
1933	Aug	NC, 2; VA, 2	2	971	----	-----
1933	Sep	TX, S3	3	949	----	-----
1933	Sep	FL, SE3	3	948	----	-----
1933	Sep	NC, 3	3	957	----	-----
1934	Jun	LA, 3	3	962	----	-----
1934	Jul	TX, S2	2	975	----	-----
1935	Sep	FL, SW5, NW2	5	892	----	"Labor Day"
1935	Nov	FL, SE2	2	973	----	-----
1936	Jun	TX, S1	1	987	----	-----
1936	Jul	FL, NW3	3	964	----	-----
1936	Sep	NC, 2	2	-----	----	-----
1938	Aug	LA, 1	1	985	----	-----
1938	Sep	NY, 3; CT, 3; RI, 3; MA, 3	3	946	----	"New England"
1939	Aug	FL, SE1, NW1	1	985	----	-----
1940	Aug	TX, N2; LA, 2	2	972	----	-----
1940	Aug	GA, 2; SC, 2	2	970	----	-----
1941	Sep	TX, N3	3	958	----	-----
1941	Oct	FL, SE2, SW2, NW2	2	975	----	-----
1942	Aug	TX, N1	1	992	----	-----
1942	Aug	TX, C3	3	950	----	-----
1943	Jul	TX, N2	2	969	----	-----
1944	Aug	NC, 1	1	990	----	-----
1944	Sep	NC, 3; VA, 3; NY, 3; CT, 3; RI, 3; MA, 2	3	947	----	-----
1944	Oct	FL, SW3, NE2	3	962	----	-----
1945	Jun	FL, NW1	1	985	----	-----
1945	Aug	TX, C2	2	967	----	-----
1945	Sep	FL, SE3	3	951	----	-----
1946	Oct	FL, SW1	1	980	----	-----
1947	Aug	TX, N1	1	992	----	-----
1947	Sep	FL, SE4, SW2; MS, 3; LA, 3	4	940	----	-----
1947	Oct	GA, 2; SC, 2; FL, SE1	2	974	----	-----
1948	Sep	LA, 1	1	987	----	-----
1948	Sep	FL, SW3, SE2	3	963	----	-----
1948	Oct	FL, SE2	2	975	----	-----
1949	Aug *	NC, 1	1	980	----	-----
1949	Aug	FL, SE3	3	954	----	-----
1949	Oct	TX, N2	2	972	----	-----
1950	Aug	AL, 1	1	980	----	Baker
1950	Sep	FL, NW3	3	958	----	Easy
1950	Oct	FL, SE3	3	955	----	King
1952	Aug	SC, 1	1	985	----	Able
1953	Aug	NC, 1	1	987	----	Barbara
1953	Sep	ME, 1	1	-----	----	Carol
1953	Sep	FL, NW1	1	985	----	Florence
1954	Aug	NY, 3; CT, 3; RI, 3; NC, 2	3	960	----	Carol
1954	Sep	MA, 3; ME, 1	3	954	----	Edna
1954	Oct	SC, 4; NC, 4; MD, 2	4	938	----	Hazel
1955	Aug	NC, 3; VA, 1	3	962	----	Connie
1955	Aug	NC, 1	1	987	----	Diane
1955	Sep	NC, 3	3	960	----	Ione
1956	Sep	LA, 2; FL, NW1	2	975	----	Flossy
1957	Jun	TX, N4; LA, 4	4	945	----	Audrey
1959	Jul	SC, 1	1	993	----	Cindy
1959	Jul	TX, N1	1	984	----	Debra

1959	Sep	SC, 3	3	950	----	Gracie
1960	Sep	FL, SW4; NC, 3; NY, 3; FL, NE2, CT, 2; RI, 2; MA, 1; NH, 1; ME, 1	4	930	----	Donna
1960	Sep	MS, 1	1	981	----	Ethel
1961	Sep	TX, C4	4	931	----	Carla
1963	Sep	TX, N1	1	996	----	Cindy
1964	Aug	FL, SE2	2	968	----	Cleo
1964	Sep	FL, NE2	2	966	----	Dora
1964	Oct	LA, 3	3	950	----	Hilda
1964	Oct	FL, SW2, SE2	2	974	----	Isbell
1965	Sep	FL, SE3; LA, 3	3	948	----	Betsy
1966	Jun	FL, NW2	2	982	----	Alma
1966	Oct	FL, SW1	1	983	----	Inez
1967	Sep	TX, S3	3	950	----	Beulah
1968	Oct	FL, NW2, NE1	2	977	----	Gladys
1969	Aug	LA, 5; MS, 5	5	909	----	Camille
1969	Sep	ME, 1	1	980	----	Gerda
1970	Aug	TX, S3	3	945	----	Celia
1971	Sep	LA, 2	2	978	----	Edith
1971	Sep	TX, C1	1	979	----	Fern
1971	Sep	NC, 1	1	995	----	Ginger
1972	Jun	FL, NW1; NY, 1; CT, 1	1	980	----	Agnes
1974	Sep	LA, 3	3	952	----	Carmen
1975	Sep	FL, NW3	3	955	----	Eloise
1976	Aug	NY, 1	1	980	----	Belle
1977	Sep	LA, 1	1	995	----	Babe
1979	Jul	LA, 1	1	986	----	Bob
1979	Sep	FL, SE2, NE2; GA, 2; SC, 2	2	970	----	David
1979	Sep	AL, 3; MS, 3	3	946	----	Frederic
1980	Aug	TX, S3	3	945	100	Allen
1983	Aug	TX, N3	3	962	100	Alicia
1984	Sep *	NC, 3	3	949	100	Diana
1985	Jul	SC, 1	1	1002	65	Bob
1985	Aug	LA, 1	1	987	80	Danny
1985	Sep	AL, 3; MS, 3; FL, NW3	3	959	100	Elena
1985	Sep	NC, 3; NY,3; CT,2; NH,2; ME,1	3	942	90	Gloria
1985	Oct	LA, 1	1	971	75	Juan
1985	Nov	FL, NW2	2	967	85	Kate
1986	Jun	TX, N1	1	990	75	Bonnie
1986	Aug	NC, 1	1	990	65	Charley
1987	Oct	FL, SW1	1	993	65	Floyd
1988	Sep	LA, 1	1	984	70	Florence
1989	Aug	TX, N1	1	986	70	Chantal
1989	Sep	SC, 4	4	934	120	Hugo
1989	Oct	TX, N1	1	983	75	Jerry
1991	Aug	RI, 2; MA, 2; NY, 2; CT, 2	2	962	90	Bob
1992	Aug	FL, SE5, SW4; LA, 3	5	922	145	Andrew
1993	Aug *	NC, 3	3	960	100	Emily
1995	Aug	FL, NW2, SE1	2	973	85	Erin
1995	Oct	FL, NW3	3	942	100	Opal
1996	Jul	NC, 2	2	974	90	Bertha
1996	Sep	NC, 3	3	954	100	Fran
1997	Jul	LA, 1; AL, 1	1	984	70	Danny
1998	Aug	NC, 2	2	964	95	Bonnie

1998	Sep	FL, NW1	1	987	70	Earl
1998	Sep	FL, SW2; MS, 2	2	964	90	Georges
1999	Aug	TX, S3	3	951	100	Bret
1999	Sep	NC, 2	2	956	90	Floyd
1999	Oct	FL, SW1	1	987	70	Irene
2002	Oct	LA, 1	1	963	80	Lili
2003	Jul	TX, C1	1	979	80	Claudette
2003	Sep	NC, 2; VA, 1	2	957	90	Isabel
2004	Aug *	NC, 1	1	972	70	Alex
2004	Aug	FL, SW4, SE1, NE1; SC,1; NC,1	4	941	130	Charley
2004	Aug	SC, 1	1	985	65	Gaston
2004	Sep	FL, SE2, SW1	2	960	90	Frances
2004	Sep	AL, 3; FL, NW3	3	946	105	Ivan
2004	Sep	FL, SE3, SW1, NW1	3	950	105	Jeanne

Notes:

States Affected and Category by States Affected: The impact of the hurricane on individual U.S. states based upon the Saffir-Simpson Scale (through the estimate of the maximum sustained surface winds at each state). TX S-South Texas, TX C-Central Texas, TX N-North Texas, LA-Louisiana, MS-Mississippi, AL-Alabama, FL NW-Northwest Florida, FL SW-Southwest Florida, FL SE-Southeast Florida, FL NE-Northeast Florida, GA-Georgia, SC-South Carolina, NC-North Carolina, VA-Virginia, MD-Maryland, DE-Delaware, NJ-New Jersey, NY-New York, PA-Pennsylvania, CT-Connecticut, RI-Rhode Island, MA-Massachusetts, NH-New Hampshire, ME-Maine. In Texas, south refers to the area from the Mexican border to Corpus Christi; central spans from north of Corpus Christi to Matagorda Bay and north refers to the region from north of Matagorda Bay to the Louisiana border. In Florida, the north-south dividing line is from Cape Canaveral [28.45N] to Tarpon Springs [28.17N]. The dividing line between west-east Florida goes from 82.69W at the north Florida border with Georgia, to Lake Okeechobee and due south along longitude 80.85W.)

Highest U.S. Saffir-Simpson Category: The highest Saffir-Simpson Hurricane Scale impact in the United States based upon estimated maximum sustained surface winds produced at the coast.

Central Pressure: The observed (or analyzed from peripheral pressure measurements) central pressure of the hurricane at landfall.

Maximum Winds: Estimated maximum sustained (1-min) surface (10 m) winds to occur along the U. S. coast. Winds are estimated to the nearest 10 kt for the period of 1851 to 1885 and to the nearest 5 kt for the period of 1886 to date. (1 kt = 1.15 mph.)

* - Indicates that the hurricane center did not make a U.S. landfall (or substantially weakened before making landfall), but did produce the indicated hurricane force winds over land. In this case, central pressure is given for the hurricane's point of closest approach.

& - Indicates that the hurricane center did make a direct landfall, but that the strongest winds likely remained offshore. Thus the winds indicated here are lower than in HURDAT.

- Indicates that the hurricane made landfall over Mexico, but also caused sustained hurricane force surface winds in Texas. The strongest winds at landfall impacted Mexico, while the weaker maximum sustained winds indicated here were conditions estimated to occur in Texas. Indicated central pressure given is that at Mexican landfall.

Additional Note: Because of the sparseness of towns and cities before 1900 in some coastal locations along the United States, the above list is not complete for all states. Before the Gulf of Mexico and Atlantic coasts became settled, hurricanes may have been underestimated in their intensity or missed completely for small-sized systems (i.e., 2004's Hurricane Charley). The following list provides estimated dates when accurate tropical cyclone records began for specified regions of the United States based upon U.S Census reports and other historical analyses. Years in parenthesis indicate possible starting dates for reliable records before the 1850s that may be available with additional research:

Texas-south - 1880, Texas-central - 1851, Texas-north - 1860, Louisiana - 1880, Mississippi - 1851, Alabama < 1851 (1830), Florida-northwest - 1880, Florida-southwest - 1900, Florida-southeast - 1900, Florida-northeast - 1880, Georgia < 1851 (1800), South Carolina < 1851 (1760), North Carolina < 1851 (1760), Virginia < 1851 (1700), Maryland < 1851 (1760), Delaware < 1851 (1700), New Jersey < 1851 (1760), New York < 1851 (1700), Connecticut < 1851 (1660), Rhode Island < 1851 (1760), Massachusetts < 1851 (1660), New Hampshire < 1851 (1660), and Maine < 1851 (1790).

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